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Ando

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(45) **Date of Patent: Mar. 22, 2016**

(54) **I/O DEVICE MANAGEMENT METHOD, COMPUTER SYSTEM, AND I/O DEVICE MANAGEMENT PROGRAM PRODUCT**

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(73) Assignee: **HITACHI, LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 479 days.

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(22) PCT Filed: **Jun. 1, 2010**

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(2), (4) Date: **Dec. 11, 2012**

(87) PCT Pub. No.: **WO2011/151930**

PCT Pub. Date: **Dec. 8, 2011**

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G06F 15/177 (2006.01)
G06F 3/06 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 15/177*** (2013.01); ***G06F 3/0613*** (2013.01); ***G06F 3/0635*** (2013.01); ***G06F 3/0689*** (2013.01)

(58) **Field of Classification Search**
CPC ... G06F 15/177; G06F 3/0635; G06F 3/0689; G06F 3/067; G06F 3/061; G06F 3/0613
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,297,262	A *	3/1994	Cox et al.	710/36
2003/0097370	A1	5/2003	Yamamoto	
2005/0267963	A1	12/2005	Baba et al.	
2006/0031389	A1 *	2/2006	Shimozono et al.	709/217
2008/0126525	A1	5/2008	Ueoka et al.	
2009/0187675	A1	7/2009	Kinoshita et al.	

FOREIGN PATENT DOCUMENTS

JP	200-200253	A	7/2000
JP	2005-301488	A	10/2005
JP	2008-083939	A	4/2008
JP	2009-075718	A	4/2009
JP	2009-175913	A	8/2009

* cited by examiner

Primary Examiner — Jonathan Bui
(74) *Attorney, Agent, or Firm* — Mattingly & Malur, PC

(57) **ABSTRACT**

An I/O device management method of a computer system including a computer, an I/O device, an I/O switch assigning the I/O device to the computer, and a management computer of managing the I/O device, in which a process of the management processor includes a step of acquiring a piece of configuration information of the I/O device assigned to the computer, and a piece of configuration information of a network connected with I/O device, a step of acquiring a flow amount indicating an amount of a data transmitted and received via the I/O device for each I/O type, a step of determining the I/O device of changing an assignment to the computer based on the pieces of acquired information, and a step of issuing an assignment change instruction to the I/O switch.

17 Claims, 26 Drawing Sheets

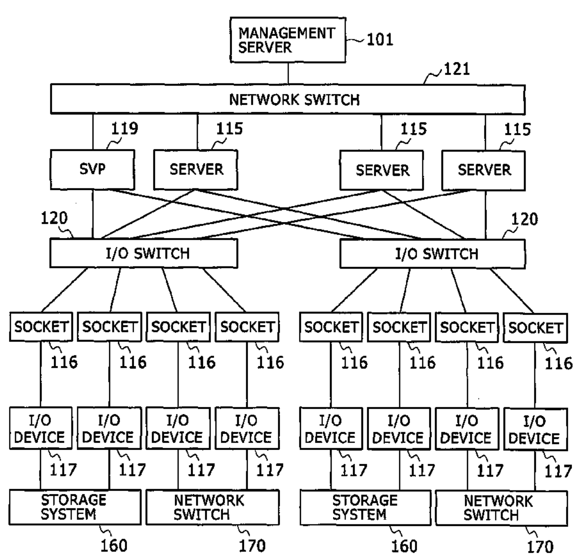


FIG. 1

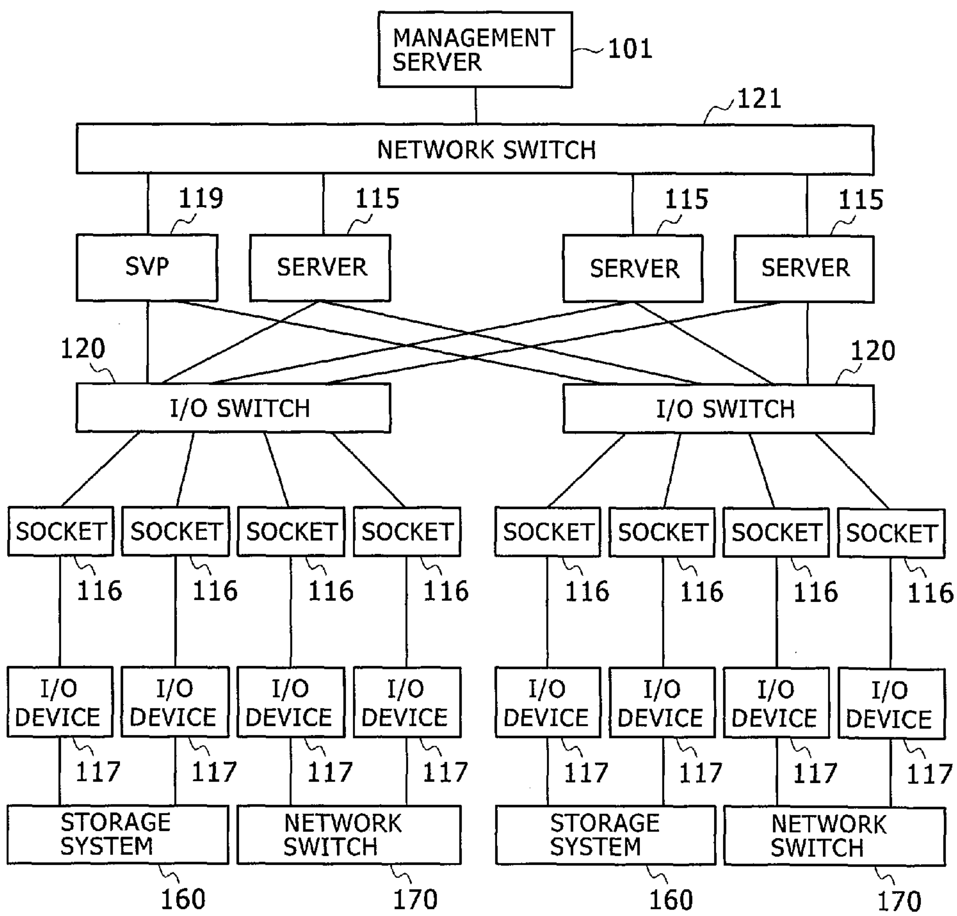
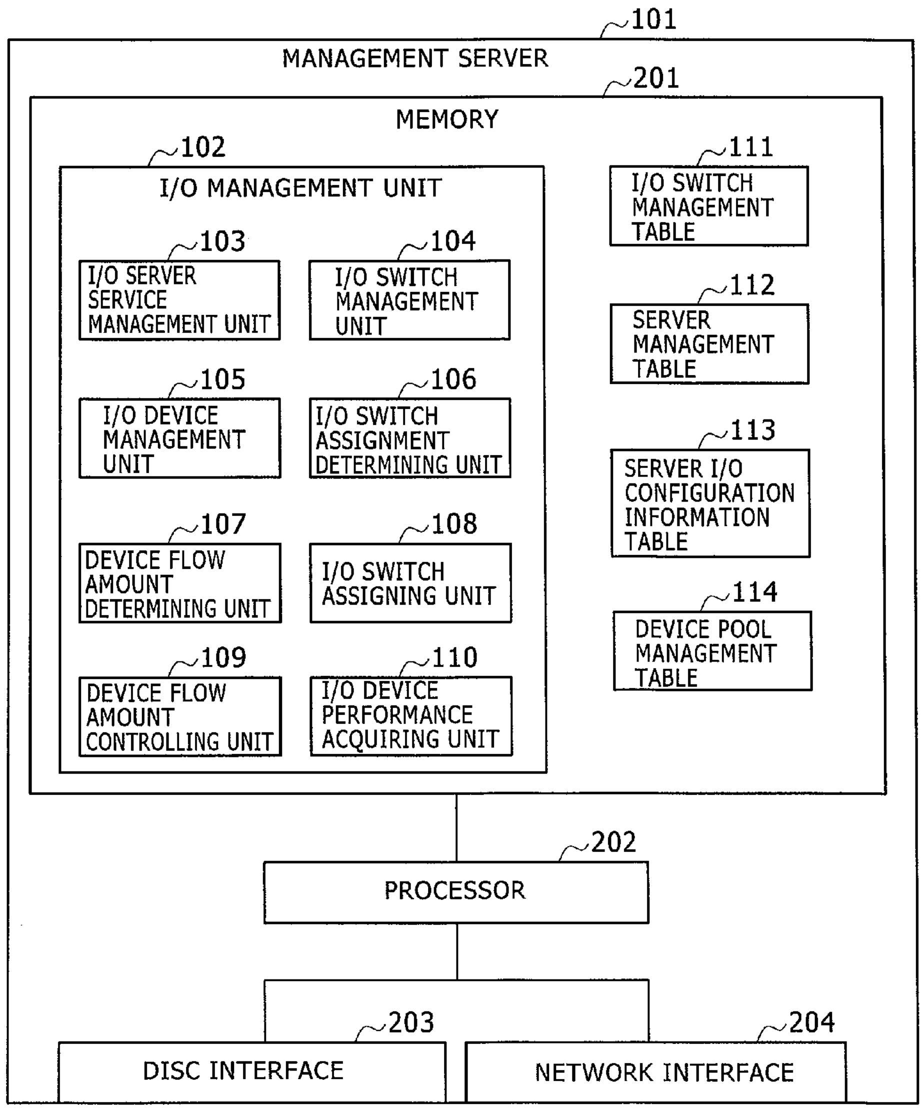

MANAGEMENT SERVER
101
121
NETWORK SWITCH
119
115
115
115
SVP
SERVER
SERVER
SERVER
120
120
I/O SWITCH
I/O SWITCH
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
116
116
116
116
116
116
116
116
I/O DEVICE
I/O DEVICE
I/O DEVICE
I/O DEVICE
I/O DEVICE
I/O DEVICE
I/O DEVICE
I/O DEVICE
117
117
117
117
117
117
117
117
STORAGE SYSTEM
NETWORK SWITCH
STORAGE SYSTEM
NETWORK SWITCH
160
170
160
170

FIG. 2



101
MANAGEMENT SERVER
201
MEMORY
102
I/O MANAGEMENT UNIT
103
I/O SERVER SERVICE MANAGEMENT UNIT
104
I/O SWITCH MANAGEMENT UNIT
105
I/O DEVICE MANAGEMENT UNIT
106
I/O SWITCH ASSIGNMENT DETERMINING UNIT
107
DEVICE FLOW AMOUNT DETERMINING UNIT
108
I/O SWITCH ASSIGNING UNIT
109
DEVICE FLOW AMOUNT CONTROLLING UNIT
110
I/O DEVICE PERFORMANCE ACQUIRING UNIT
111
I/O SWITCH MANAGEMENT TABLE
112
SERVER MANAGEMENT TABLE
113
SERVER I/O CONFIGURATION INFORMATION TABLE
114
DEVICE POOL MANAGEMENT TABLE
202
PROCESSOR
203
DISC INTERFACE
204
NETWORK INTERFACE

FIG.3

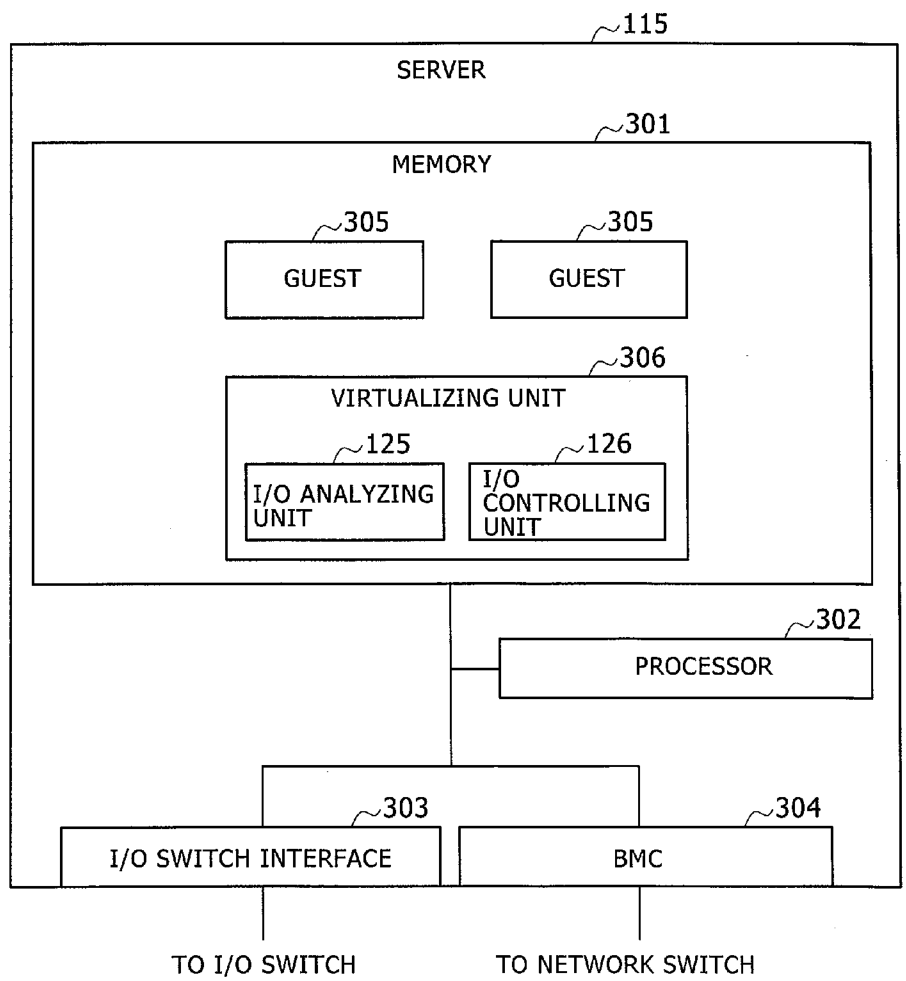

115
SERVER
301
MEMORY
305
GUEST
305
GUEST
306
VIRTUALIZING UNIT
125
I/O ANALYZING UNIT
126
I/O CONTROLLING UNIT
302
PROCESSOR
303
I/O SWITCH INTERFACE
304
BMC
TO I/O SWITCH
TO NETWORK SWITCH

FIG. 4

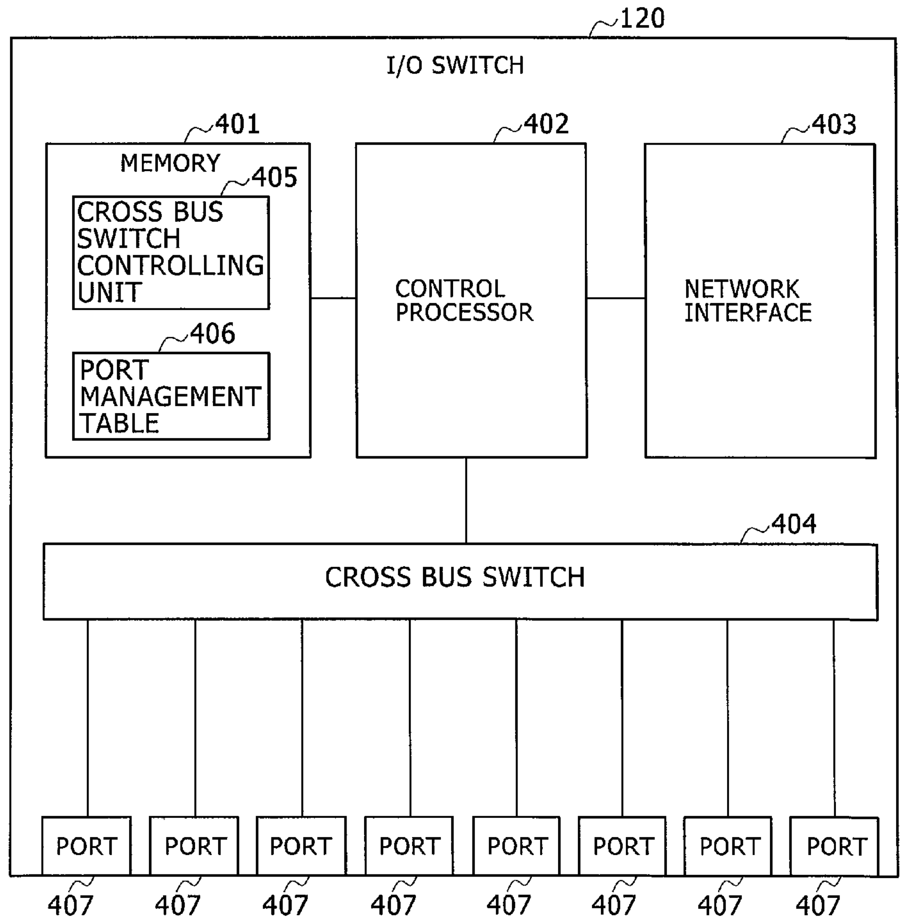

120
I/O SWITCH
401
MEMORY
405
CROSS BUS SWITCH CONTROLLING UNIT
406
PORT MANAGEMENT TABLE
402
CONTROL PROCESSOR
403
NETWORK INTERFACE
404
CROSS BUS SWITCH
PORT
PORT
PORT
PORT
PORT
PORT
PORT
PORT
407
407
407
407
407
407
407
407

FIG. 5

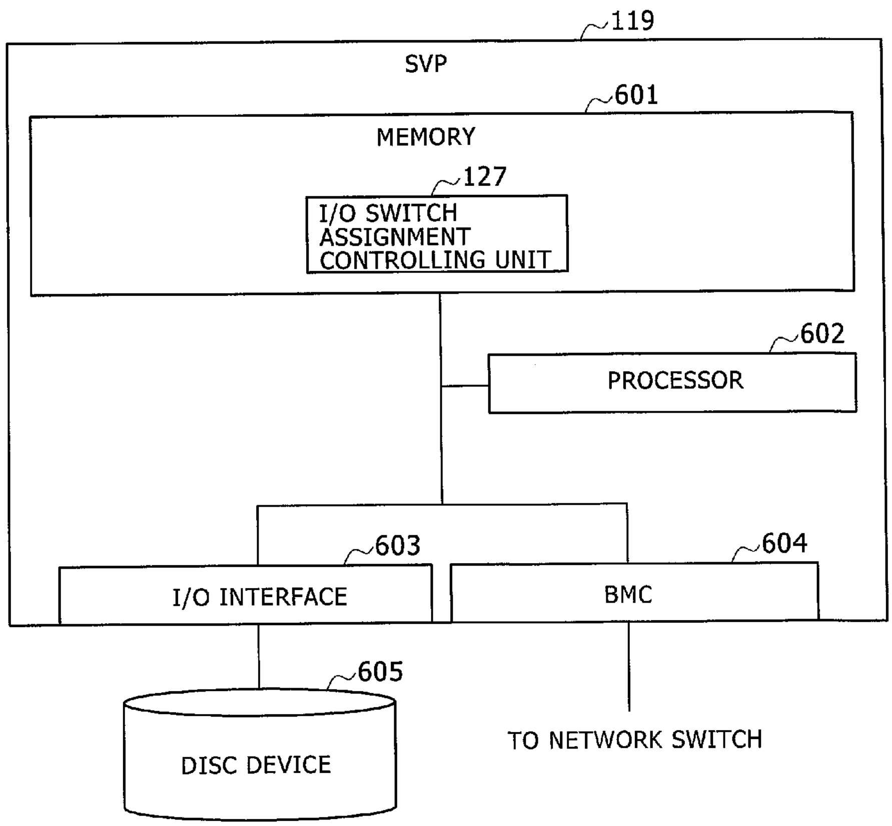

119
SVP
601
MEMORY
127
I/O SWITCH ASSIGNMENT CONTROLLING UNIT
602
PROCESSOR
603
I/O INTERFACE
604
BMC
605
DISC DEVICE
TO NETWORK SWITCH

FIG. 6

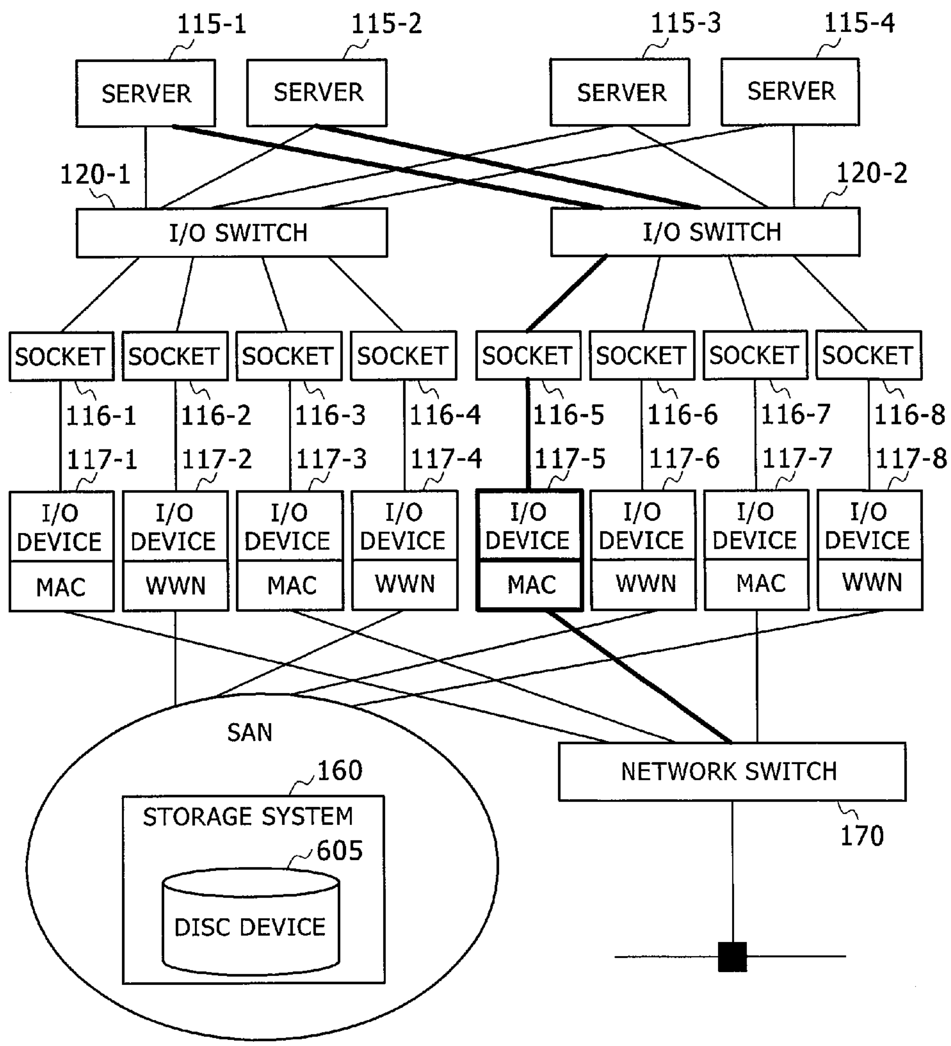

115-1
115-2
115-3
115-4
SERVER
SERVER
SERVER
SERVER
120-1
120-2
I/O SWITCH
I/O SWITCH
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
116-1
116-2
116-3
116-4
116-5
116-6
116-7
116-8
117-1
117-2
117-3
117-4
117-5
117-6
117-7
117-8
I/O DEVICE
MAC
I/O DEVICE
WWN
I/O DEVICE
MAC
I/O DEVICE
WWN
I/O DEVICE
MAC
I/O DEVICE
WWN
I/O DEVICE
MAC
I/O DEVICE
WWN
SAN
160
STORAGE SYSTEM
605
DISC DEVICE
NETWORK SWITCH
170

FIG. 7

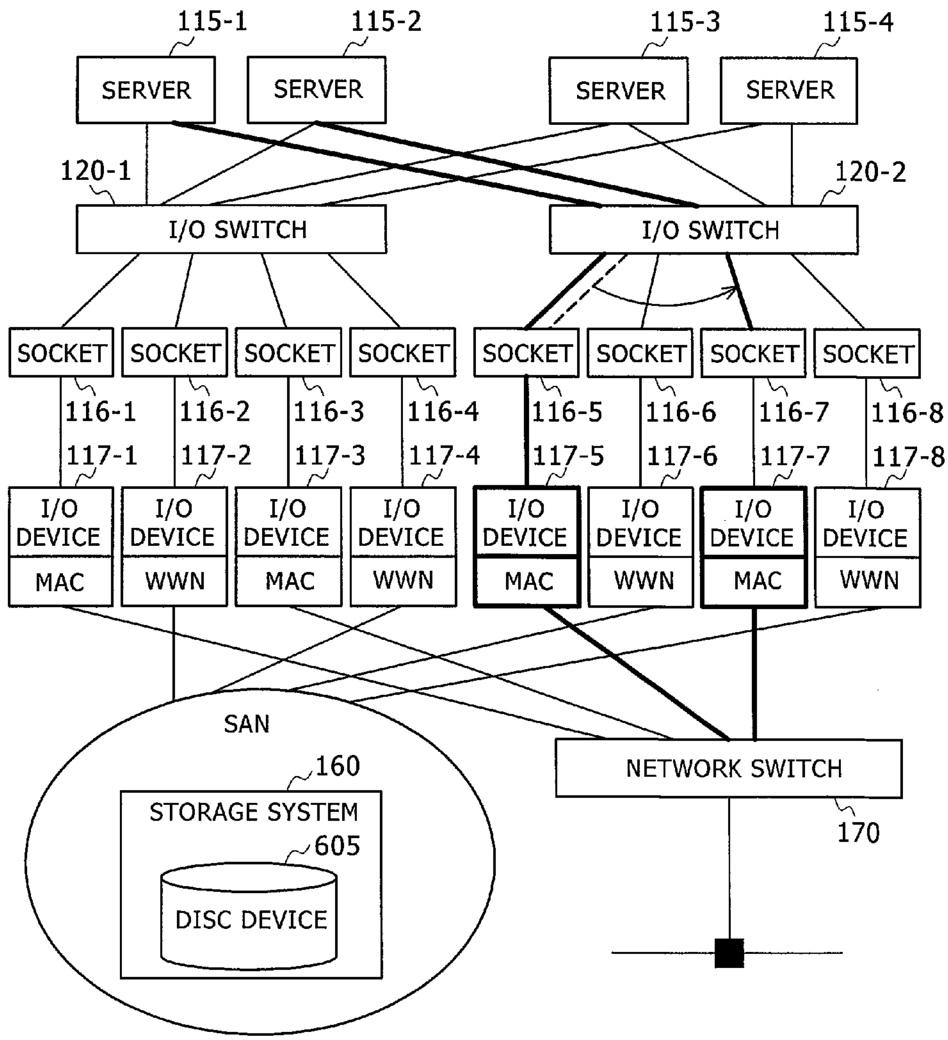

115-1
115-2
115-3
115-4
SERVER
SERVER
SERVER
SERVER
120-1
120-2
I/O SWITCH
I/O SWITCH
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
SOCKET
116-1
116-2
116-3
116-4
116-5
116-6
116-7
116-8
117-1
117-2
117-3
117-4
117-5
117-6
117-7
117-8
I/O DEVICE
MAC
I/O DEVICE
WWN
I/O DEVICE
MAC
I/O DEVICE
WWN
I/O DEVICE
MAC
I/O DEVICE
WWN
I/O DEVICE
MAC
I/O DEVICE
WWN
SAN
160
STORAGE SYSTEM
605
DISC DEVICE
NETWORK SWITCH
170

FIG. 8

I/O SWITCH MANAGEMENT TABLE

111

I/O SWITCH IDENTIFIER (1111)	PORT NUMBER (1112)	CONNECTION DESTINATION (1113)	CONNECTION DESTINATION IDENTIFIER (1114)	STATE (1115)	CONSUMED BAND RATE (1116)	BAND RESTRICTION RANGE (1117)	SHARING USE (1118)
SW1	0	NIC	MAC1	NORMAL	50%	20-90	POSSIBLE
	1	HBA	WWN1	NORMAL	100%	50-70	POSSIBLE
	2	NIC	MAC2	NORMAL	50%	20-90	POSSIBLE
	3	HBA	WWN2	NORMAL	10%	50-70	POSSIBLE
	4	HOST	HOST1	NORMAL	80%	–	–
	5	HOST	HOST2	NORMAL	25%	–	–
	6	HOST	HOST3	NORMAL	0%	–	–
	7	HOST	HOST4	NORMAL	0%	–	–
SW2	0	NIC	MAC3	NORMAL	80%	20-90	POSSIBLE
	1	HBA	WWN3	NORMAL	25%	–	IMPOSSIBLE
	2	NIC	MAC3	NORMAL	10%	50-70	POSSIBLE
	3	HBA	WWN4	NORMAL	50%	50-70	POSSIBLE
	4	HOST	HOST5	NORMAL	80%	–	–
	5	HOST	HOST6	NORMAL	50%	–	–
	6	HOST	HOST7	NORMAL	0%	–	–
	7	CNA	MAC5	NORMAL	80%(LAN) 20%(SAN)	20-90	POSSIBLE

FIG. 9

SERVER MANAGEMENT TABLE

112

SERVER IDENTIFIER (1121)	PROCESSOR CONFIGURATION (1122)	MEMORY CAPACITY (1123)	I/O DEFINITION (1124)	SERVICE TYPE (0: DEVICE) (1: SWITCH) (1125)
HOST1	PROCESSOR1 2GHz×2	4GB	DEFINITION 1 DEFINITION 2 DEFINITION 3	0
HOST2	PROCESSOR1 1GHz	2GB	DEFINITION 1 DEFINITION 2	0
HOST3	PROCESSOR1 1GHz	2GB	DEFINITION 1 DEFINITION 2	1
HOST4	PROCESSOR1 1GHz	2GB	DEFINITION 1 DEFINITION 2	0

FIG. 10

SERVER I/O CONFIGURATION INFORMATION TABLE 113

DEFINITION 1138	I/O SWITCH IDENTIFIER 1131	PORT NUMBER 1132	CONNECTION DEVICE 1133	COMMUNICATION DESTINATION 1134	IMPORTANCE DEGREE 1135
1	SW1	0	HBA	SAN1	High
	SW1	2	HBA	SAN2	High
	SW1	7	HBA	SAN3	Low
	SW2	3	NIC	G/W1	High
2	SW1	0	HBA	SAN1	High
	SW1	2	HBA	SAN2	High
	SW1	8	NIC	G/W2	High
	SW2	3	NIC	G/W1	Low
3	SW1	0	HBA	SAN1	High
	SW1	2	HBA	SAN2	High
	SW2	3	NIC	G/W1	High
	SW2	7	SCSI	DVD-RPM	High

FIG. 11

DEVICE POOL MANAGEMENT TABLE

114

<table>
<tr><th>I/O SWITCH IDENTIFIER (1141)</th><th>PORT NUMBER (1142)</th><th>ASSIGNED STATE (1143)</th><th>DEVICE POOL ASSIGNMENT (1144)</th></tr>
<tr><td rowspan="8">SW1</td><td>0</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>1</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>2</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>3</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>4</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>5</td><td>NOT ASSIGNED YET</td><td rowspan="2">DEVICE POOL 1</td></tr>
<tr><td>6</td><td>ASSIGNED</td></tr>
<tr><td>7</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td rowspan="8">SW2</td><td>0</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>1</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>2</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>3</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>4</td><td>ASSIGNED</td><td>—</td></tr>
<tr><td>5</td><td>ASSIGNED</td><td></td></tr>
<tr><td>6</td><td>NOT ASSIGNED YET</td><td rowspan="2">DEVICE POOL 2</td></tr>
<tr><td>7</td><td>NOT ASSIGNED YET</td></tr>
</table>

FIG. 12

PORT MANAGEMENT TABLE

406

PHYSICAL PORT NUMBER (4061)	ASSIGNED GROUP (4062)	LOGICAL PORT NUMBER (4063)
0	0	0
1	0	1
2	1	0
3	1	1
4	0	0,1
5	–	–
6	–	–
7	1	0,1

FIG. 13

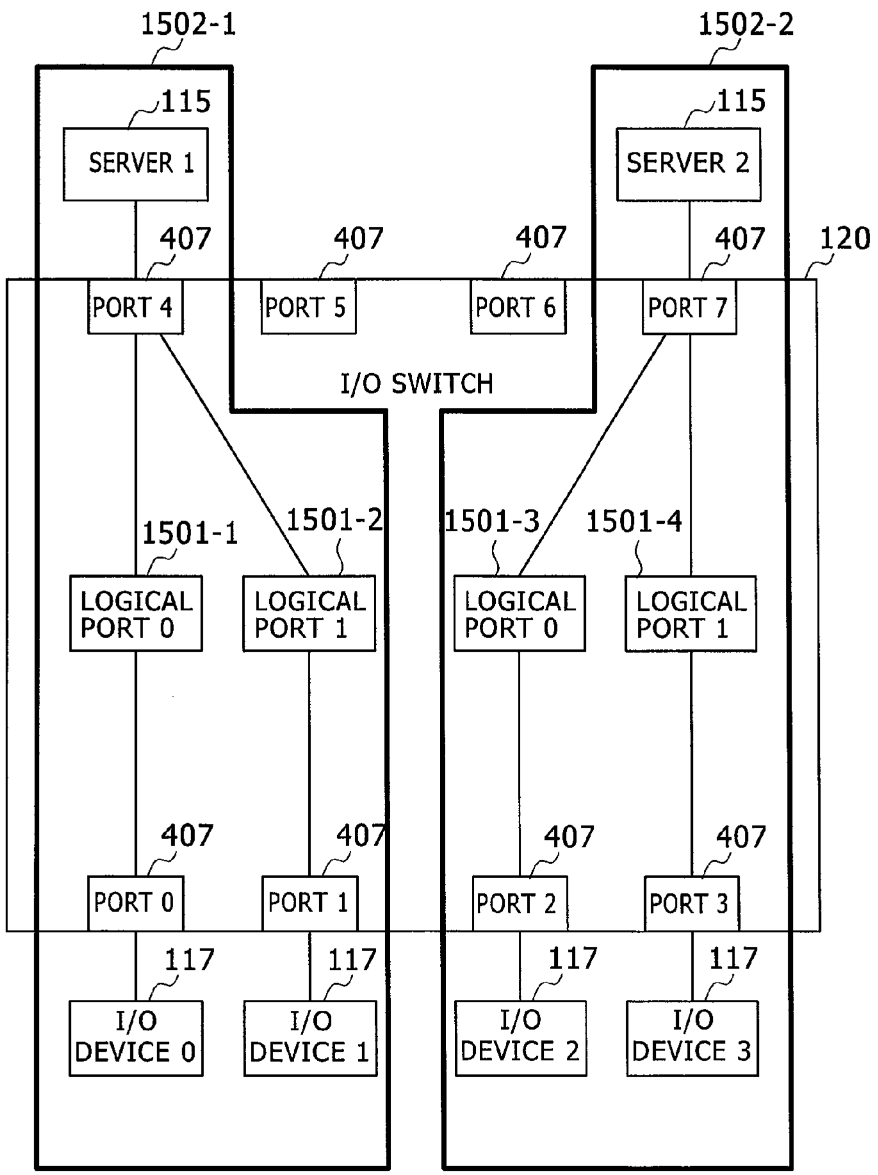

1502-1
1502-2
115
SERVER 1
115
SERVER 2
407
120
PORT 4
PORT 5
PORT 6
PORT 7
I/O SWITCH
1501-1
1501-2
1501-3
1501-4
LOGICAL PORT 0
LOGICAL PORT 1
LOGICAL PORT 0
LOGICAL PORT 1
PORT 0
PORT 1
PORT 2
PORT 3
117
I/O DEVICE 0
I/O DEVICE 1
I/O DEVICE 2
I/O DEVICE 3

FIG.14

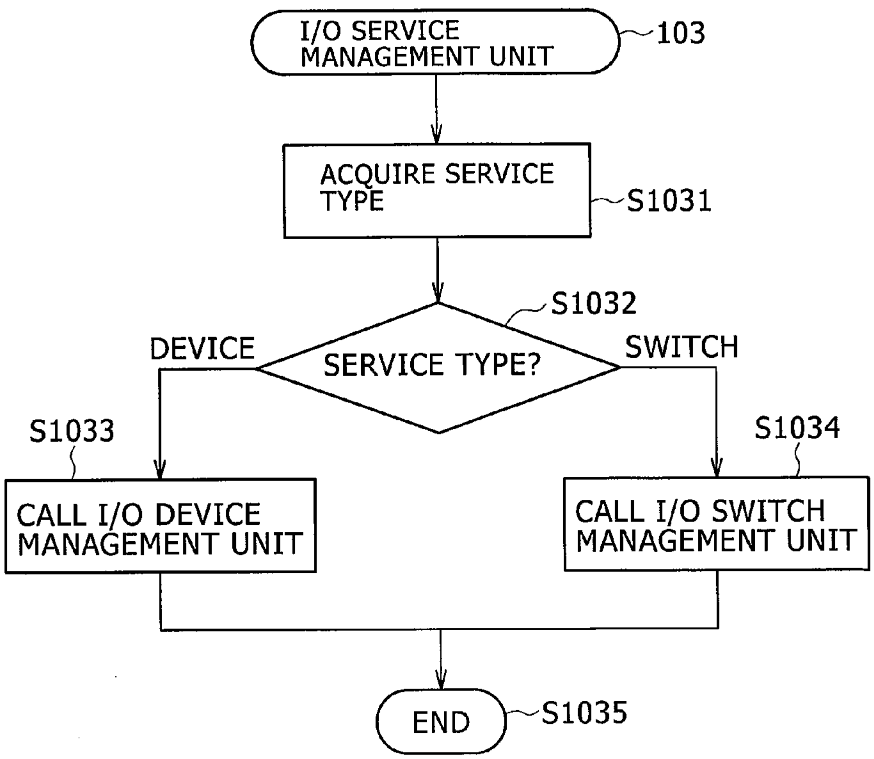
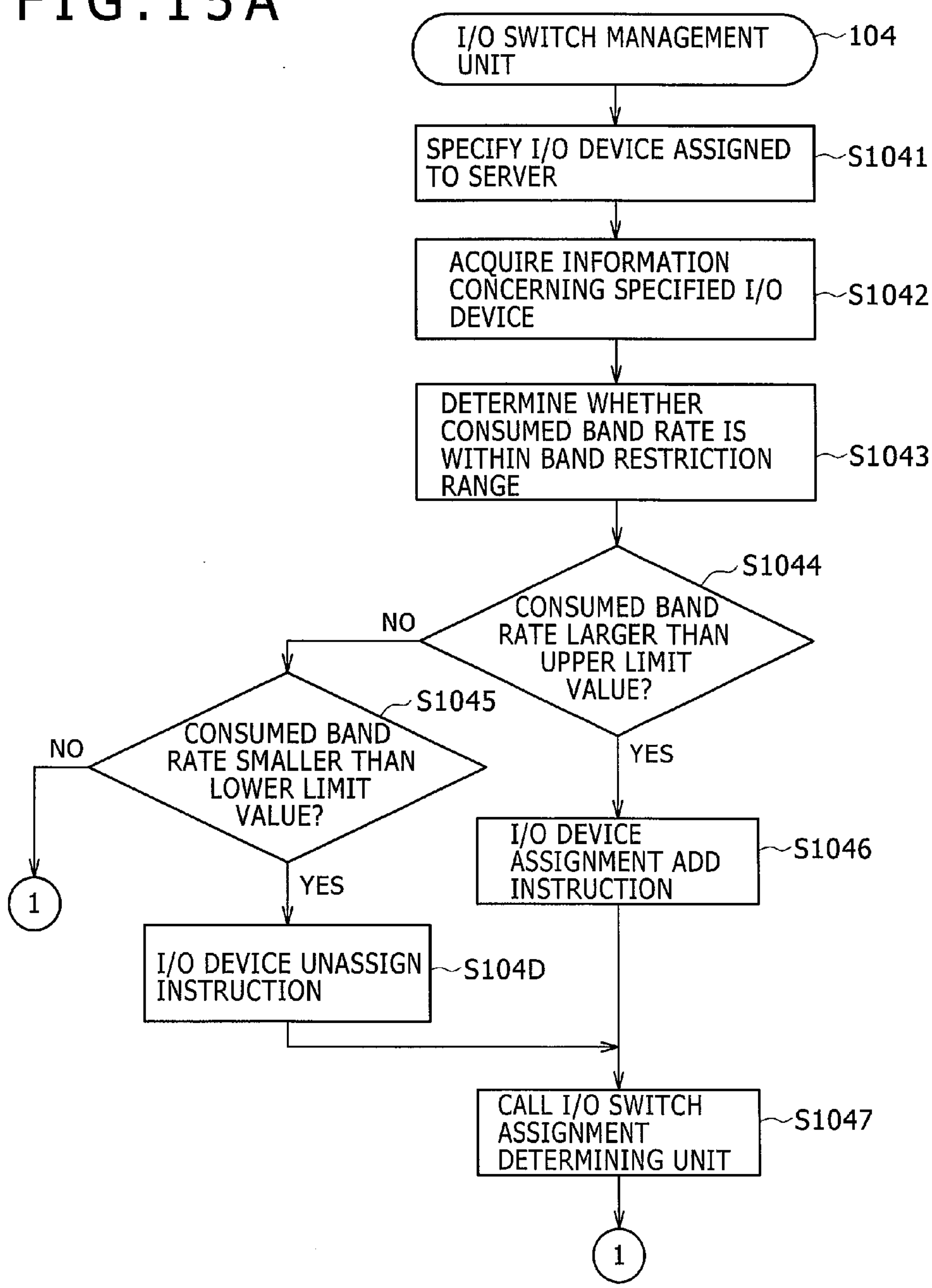

I/O SERVICE MANAGEMENT UNIT
103
ACQUIRE SERVICE TYPE
S1031
S1032
SERVICE TYPE?
DEVICE
SWITCH
S1033
S1034
CALL I/O DEVICE MANAGEMENT UNIT
CALL I/O SWITCH MANAGEMENT UNIT
END
S1035

FIG.15A



I/O SWITCH MANAGEMENT UNIT
104
SPECIFY I/O DEVICE ASSIGNED TO SERVER
S1041
ACQUIRE INFORMATION CONCERNING SPECIFIED I/O DEVICE
S1042
DETERMINE WHETHER CONSUMED BAND RATE IS WITHIN BAND RESTRICTION RANGE
S1043
CONSUMED BAND RATE LARGER THAN UPPER LIMIT VALUE?
S1044
NO
YES
CONSUMED BAND RATE SMALLER THAN LOWER LIMIT VALUE?
S1045
NO
YES
1
I/O DEVICE ASSIGNMENT ADD INSTRUCTION
S1046
I/O DEVICE UNASSIGN INSTRUCTION
S104D
CALL I/O SWITCH ASSIGNMENT DETERMINING UNIT
S1047
1

FIG. 15B

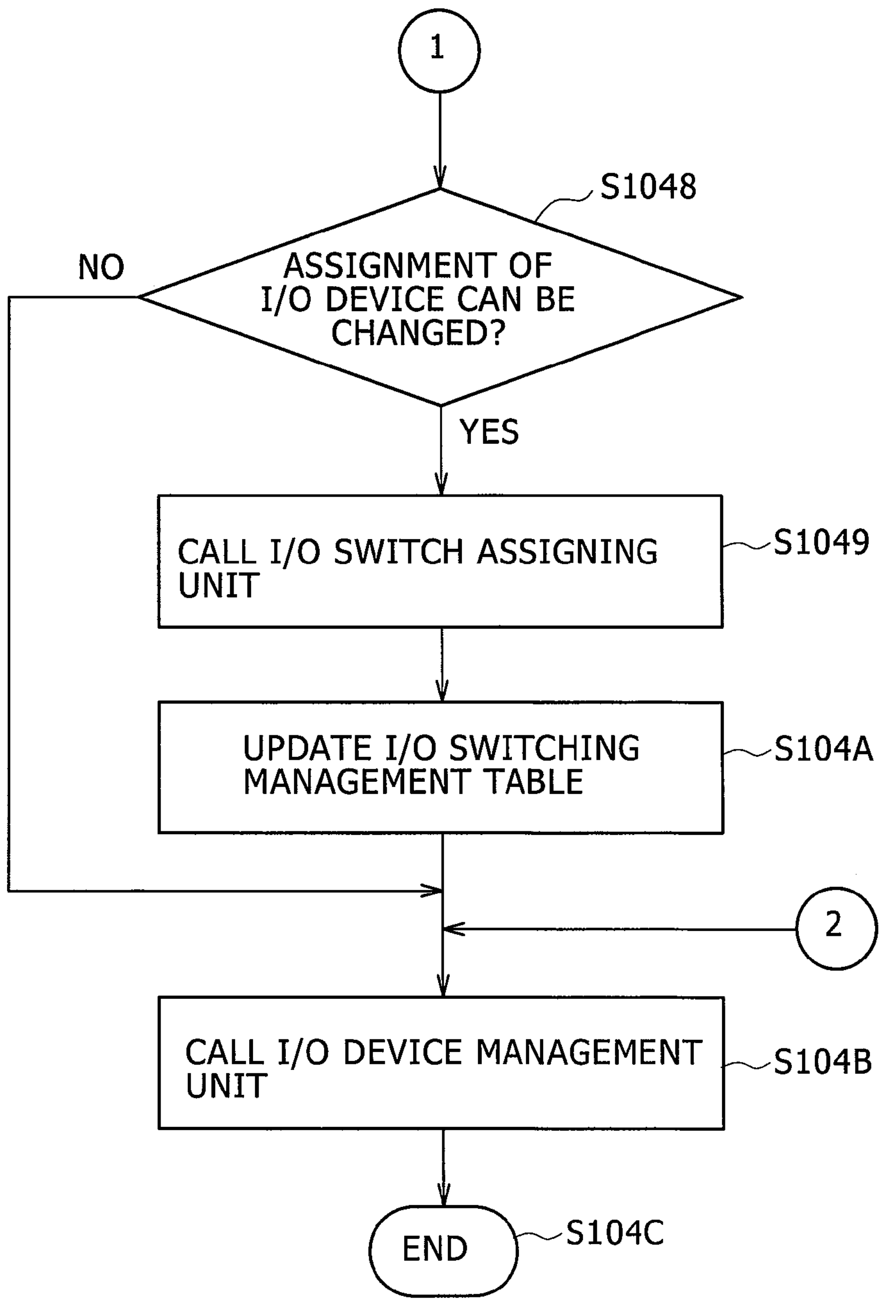
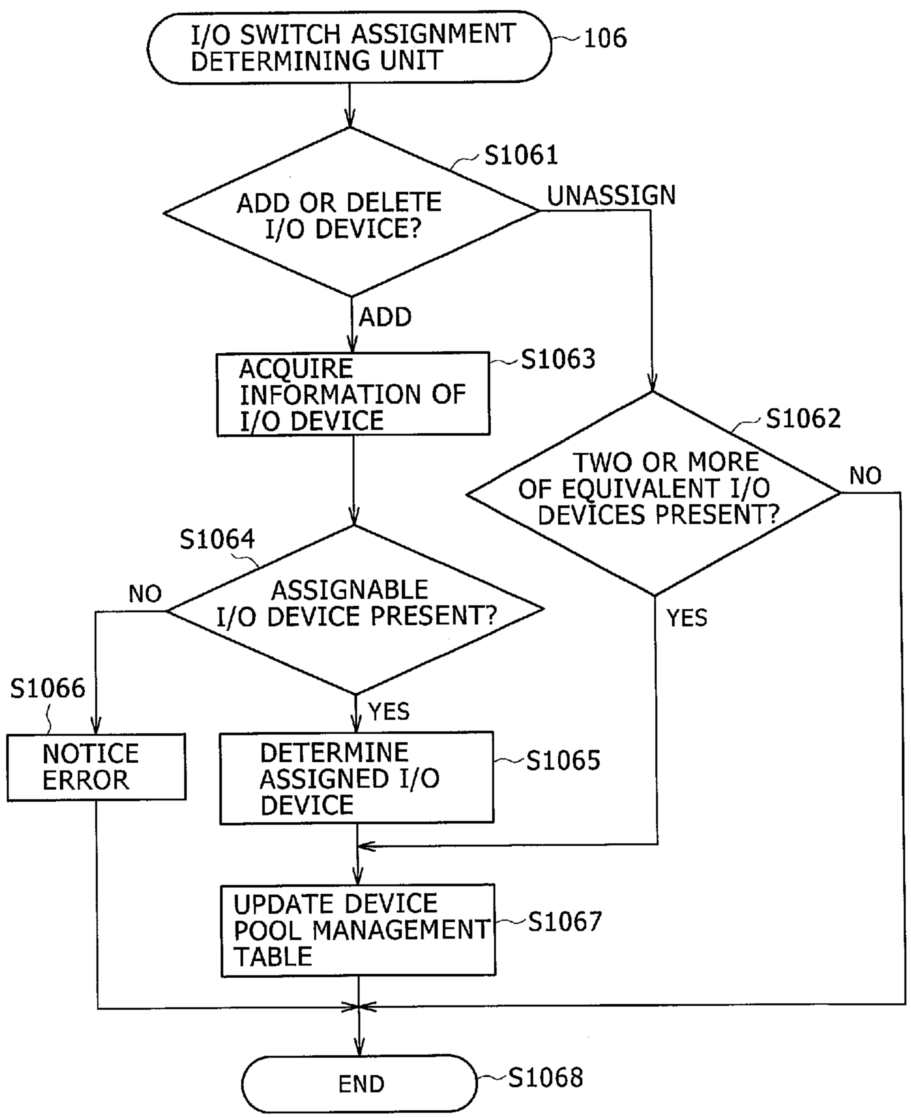

1
S1048
ASSIGNMENT OF I/O DEVICE CAN BE CHANGED?
NO
YES
CALL I/O SWITCH ASSIGNING UNIT
S1049
UPDATE I/O SWITCHING MANAGEMENT TABLE
S104A
2
CALL I/O DEVICE MANAGEMENT UNIT
S104B
END
S104C

FIG.16



I/O SWITCH ASSIGNMENT DETERMINING UNIT
106
ADD OR DELETE I/O DEVICE?
S1061
UNASSIGN
ADD
ACQUIRE INFORMATION OF I/O DEVICE
S1063
TWO OR MORE OF EQUIVALENT I/O DEVICES PRESENT?
S1062
NO
S1064
ASSIGNABLE I/O DEVICE PRESENT?
NO
YES
S1066
NOTICE ERROR
YES
DETERMINE ASSIGNED I/O DEVICE
S1065
UPDATE DEVICE POOL MANAGEMENT TABLE
S1067
END
S1068

FIG. 17

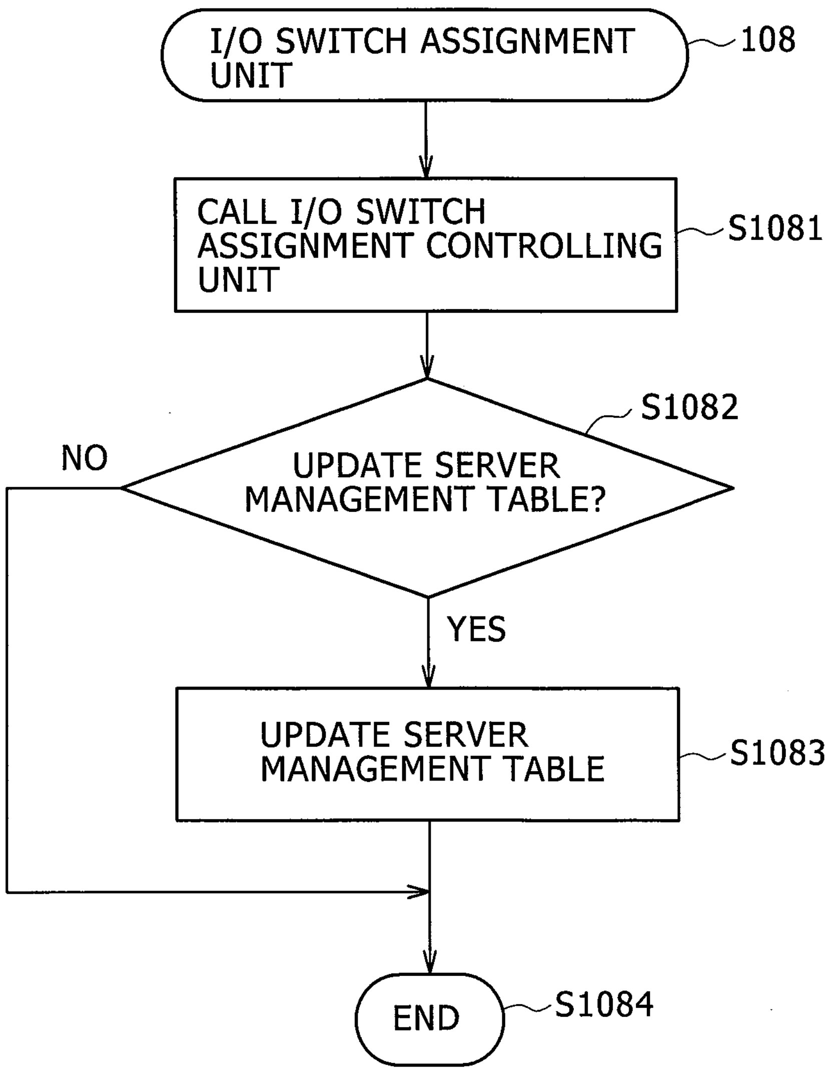

I/O SWITCH ASSIGNMENT UNIT
108
CALL I/O SWITCH ASSIGNMENT CONTROLLING UNIT
S1081
S1082
NO
UPDATE SERVER MANAGEMENT TABLE?
YES
UPDATE SERVER MANAGEMENT TABLE
S1083
END
S1084

FIG.18

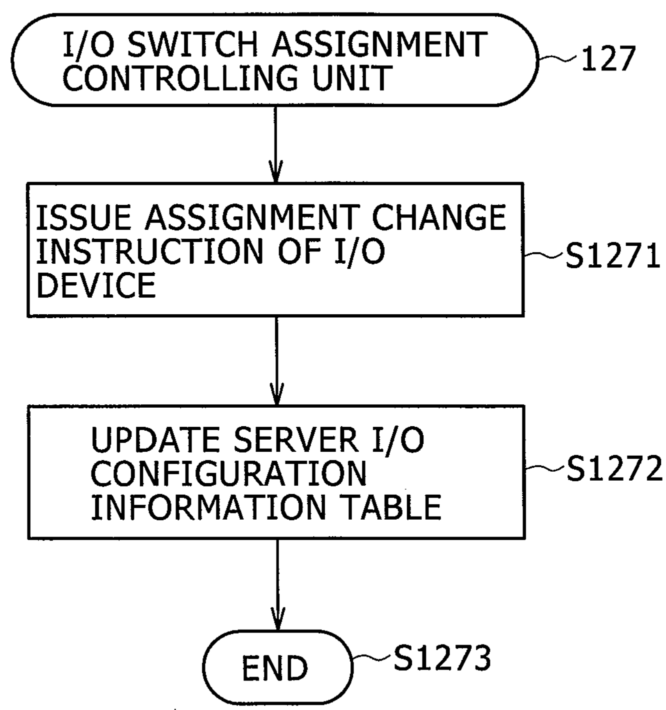

I/O SWITCH ASSIGNMENT CONTROLLING UNIT
127
ISSUE ASSIGNMENT CHANGE INSTRUCTION OF I/O DEVICE
S1271
UPDATE SERVER I/O CONFIGURATION INFORMATION TABLE
S1272
END
S1273

FIG. 19

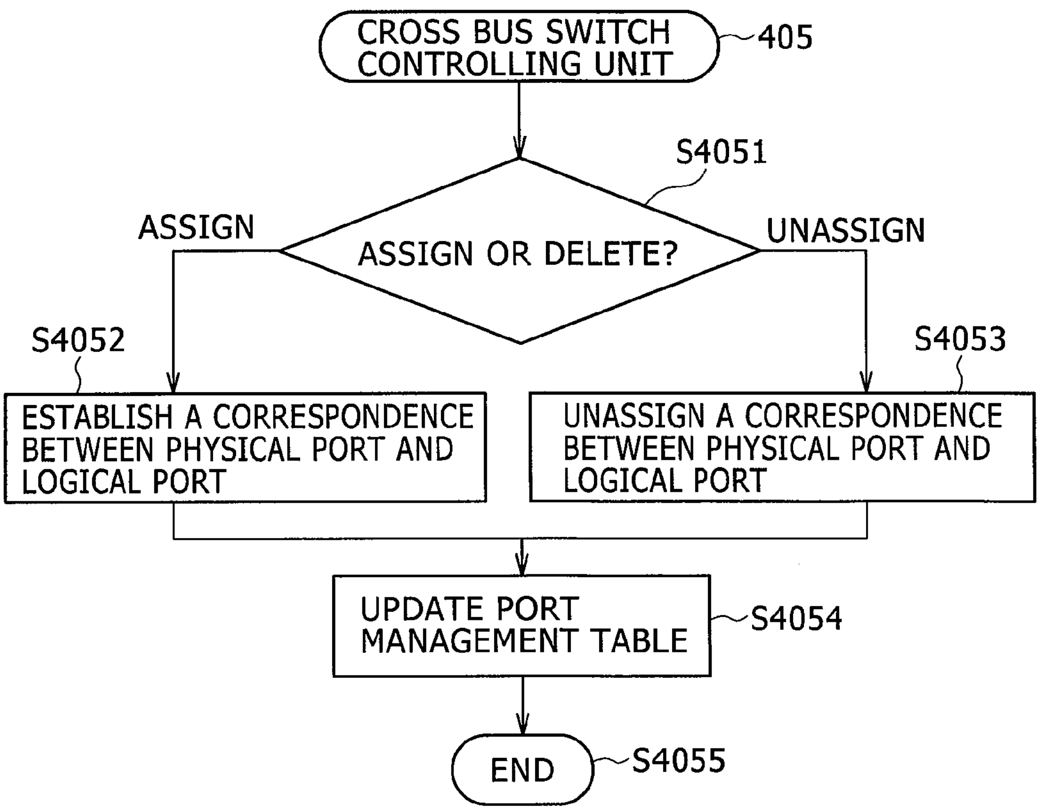
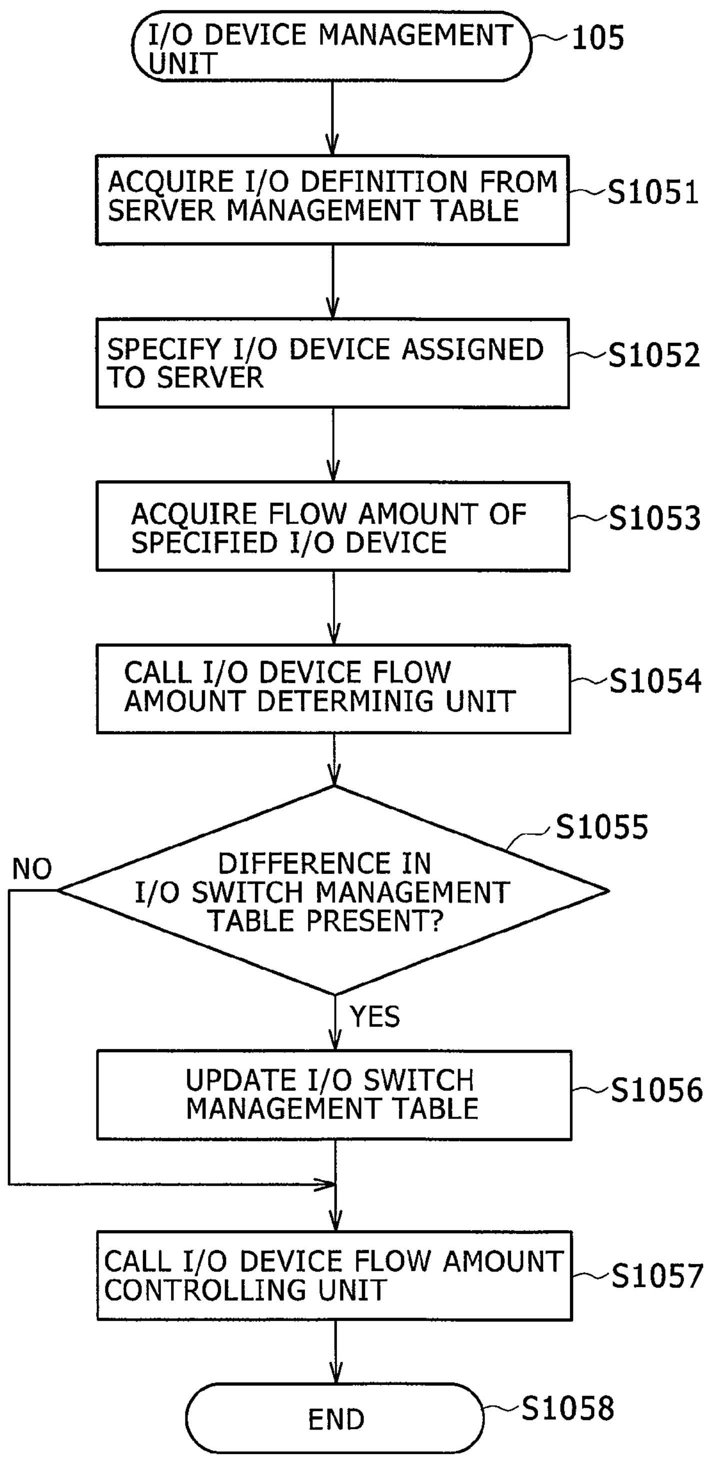

CROSS BUS SWITCH CONTROLLING UNIT
405
S4051
ASSIGN
ASSIGN OR DELETE?
UNASSIGN
S4052
S4053
ESTABLISH A CORRESPONDENCE BETWEEN PHYSICAL PORT AND LOGICAL PORT
UNASSIGN A CORRESPONDENCE BETWEEN PHYSICAL PORT AND LOGICAL PORT
UPDATE PORT MANAGEMENT TABLE
S4054
END
S4055

FIG. 20



I/O DEVICE MANAGEMENT UNIT
105
ACQUIRE I/O DEFINITION FROM SERVER MANAGEMENT TABLE
S1051
SPECIFY I/O DEVICE ASSIGNED TO SERVER
S1052
ACQUIRE FLOW AMOUNT OF SPECIFIED I/O DEVICE
S1053
CALL I/O DEVICE FLOW AMOUNT DETERMINIG UNIT
S1054
DIFFERENCE IN I/O SWITCH MANAGEMENT TABLE PRESENT?
S1055
NO
YES
UPDATE I/O SWITCH MANAGEMENT TABLE
S1056
CALL I/O DEVICE FLOW AMOUNT CONTROLLING UNIT
S1057
END
S1058

FIG.21

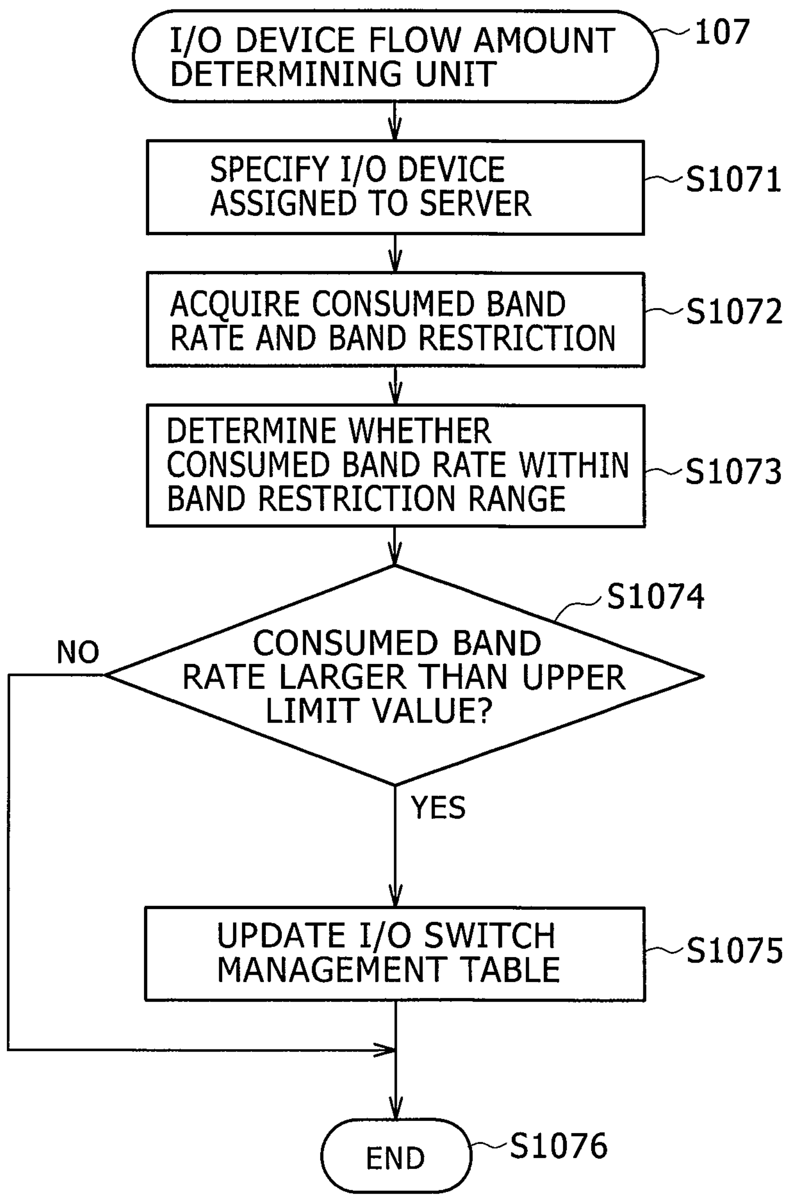

I/O DEVICE FLOW AMOUNT DETERMINING UNIT
107
SPECIFY I/O DEVICE ASSIGNED TO SERVER
S1071
ACQUIRE CONSUMED BAND RATE AND BAND RESTRICTION
S1072
DETERMINE WHETHER CONSUMED BAND RATE WITHIN BAND RESTRICTION RANGE
S1073
CONSUMED BAND RATE LARGER THAN UPPER LIMIT VALUE?
S1074
NO
YES
UPDATE I/O SWITCH MANAGEMENT TABLE
S1075
END
S1076

FIG.22

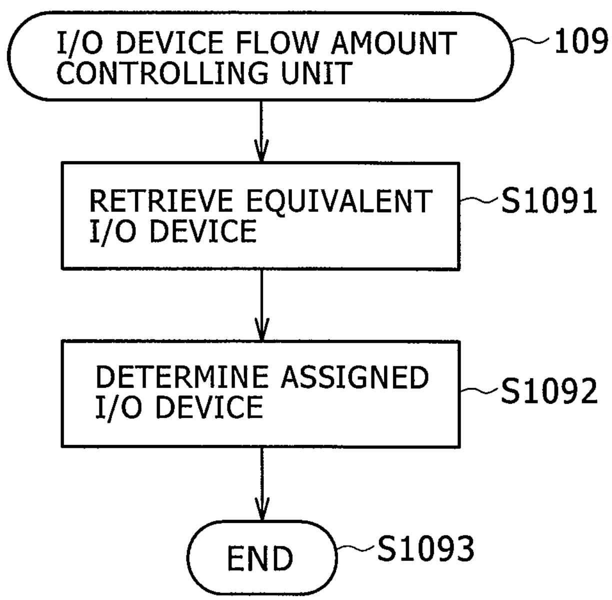

I/O DEVICE FLOW AMOUNT CONTROLLING UNIT
109
RETRIEVE EQUIVALENT I/O DEVICE
S1091
DETERMINE ASSIGNED I/O DEVICE
S1092
END
S1093

FIG.23

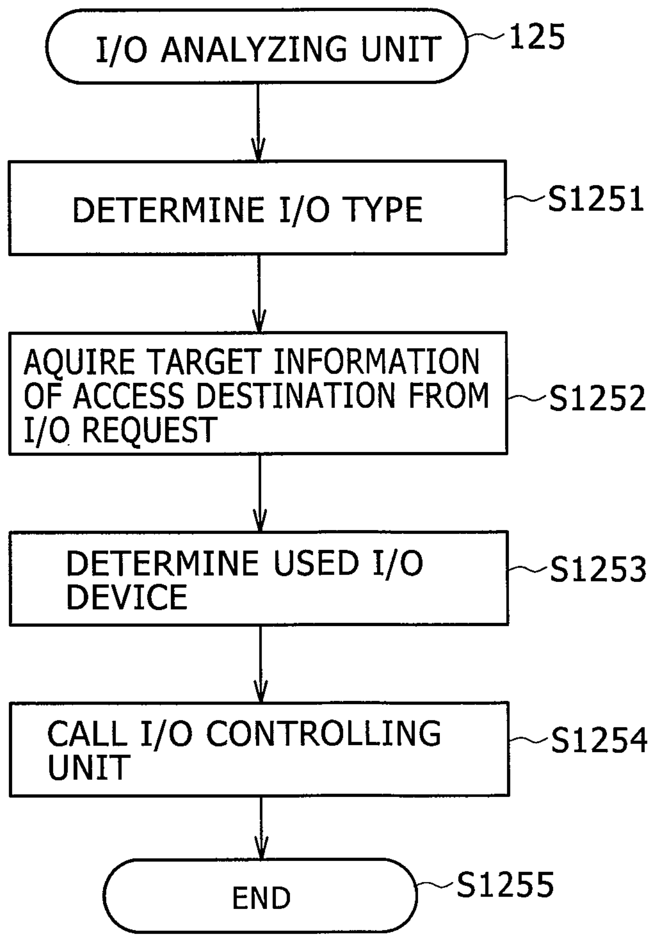

I/O ANALYZING UNIT
125
DETERMINE I/O TYPE
S1251
AQUIRE TARGET INFORMATION OF ACCESS DESTINATION FROM I/O REQUEST
S1252
DETERMINE USED I/O DEVICE
S1253
CALL I/O CONTROLLING UNIT
S1254
END
S1255

FIG.24

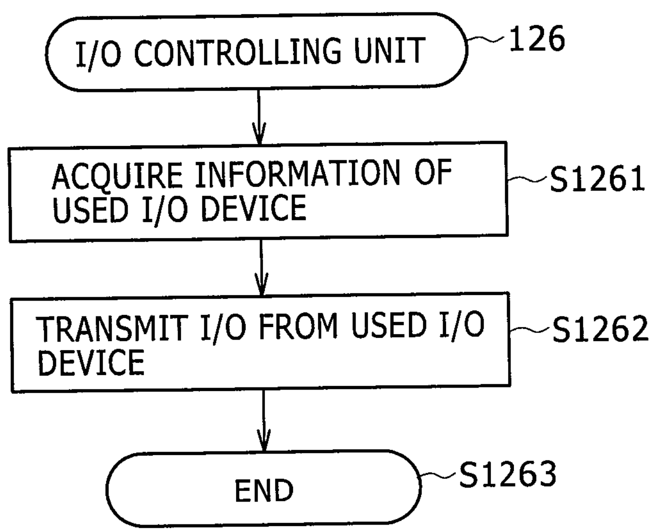
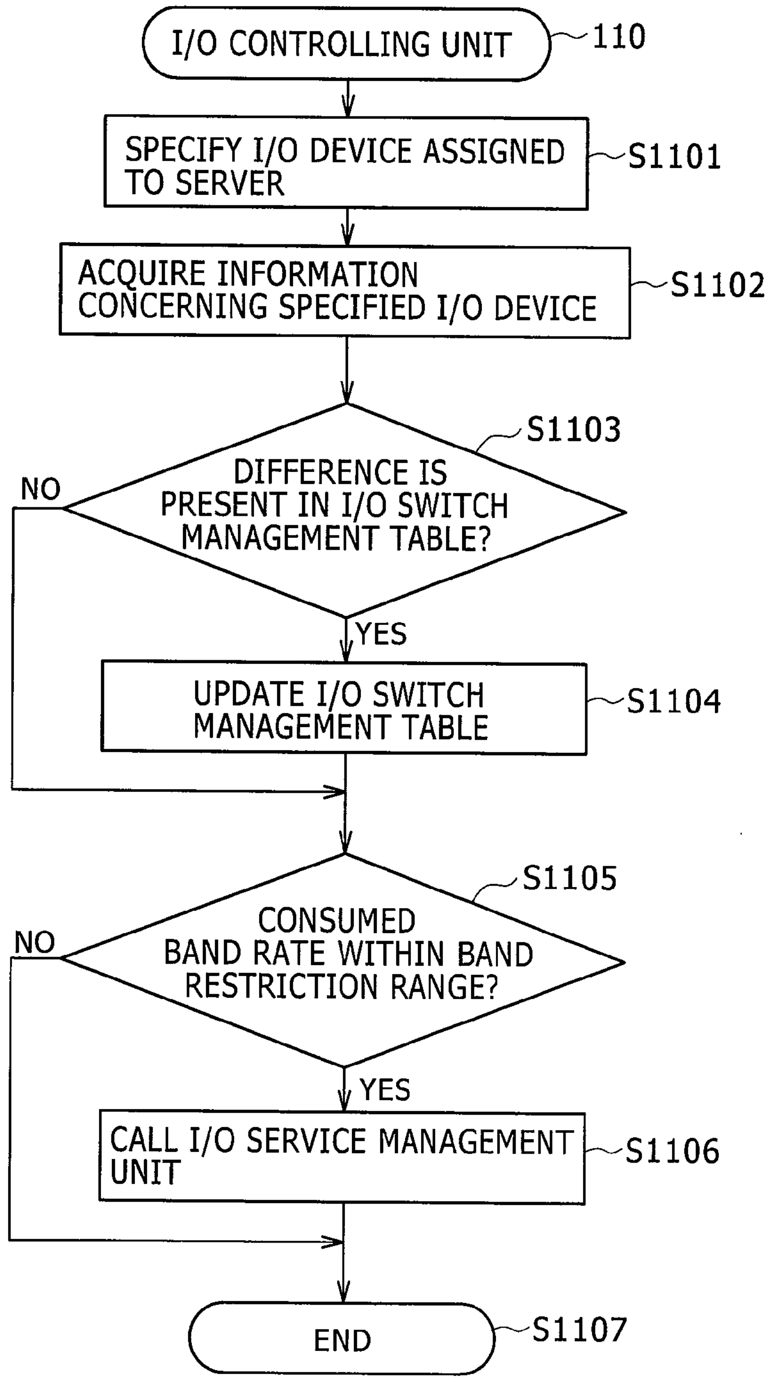

I/O CONTROLLING UNIT
126
ACQUIRE INFORMATION OF USED I/O DEVICE
S1261
TRANSMIT I/O FROM USED I/O DEVICE
S1262
END
S1263

FIG.25


I/O CONTROLLING UNIT
110
SPECIFY I/O DEVICE ASSIGNED TO SERVER
S1101
ACQUIRE INFORMATION CONCERNING SPECIFIED I/O DEVICE
S1102
DIFFERENCE IS PRESENT IN I/O SWITCH MANAGEMENT TABLE?
S1103
NO
YES
UPDATE I/O SWITCH MANAGEMENT TABLE
S1104
CONSUMED BAND RATE WITHIN BAND RESTRICTION RANGE?
S1105
NO
YES
CALL I/O SERVICE MANAGEMENT UNIT
S1106
END
S1107

I/O DEVICE MANAGEMENT METHOD, COMPUTER SYSTEM, AND I/O DEVICE MANAGEMENT PROGRAM PRODUCT

FIELD OF THE INVENTION

The present invention relates to a computer system which carries out a network communication, particularly relates to a technology for increasing an I/O transfer efficiency in an environment of being connected to a client system via different types of plural network communications.

BACKGROUND OF THE INVENTION

According to a processing distribution system of a background art, loads are distributed by determining a network path which is used by a unit of a processing program in order to increase an I/O transfer efficiency. Also, a processing performance of a processing distribution system is improved by determining a number of network paths which are used for realizing an aimed processing performance by editing and analyzing information showing a past processing result as statistical analysis information (for example, refer to Japanese Unexamined Patent Application Publication No. 2000-200253).

Japanese Unexamined Patent Application Publication No. 2000-200253 describes a processing system which prevents a reduction in a throughput of transactions that occur by concentrating a load on a specific communication resource and a specific server resource by using information of presence/absence of a failure, a load, and an operational state of the communication resource in a database load distribution processing system that distributes loads of accesses to distributed databases that are managed by plural servers. Thereby, an efficiency of processing transactions can be increased.

SUMMARY OF THE INVENTION

According to a computer system including plural transfer resources (hereinafter, referred to as I/O device), it is necessary to select an I/O device used in consideration of a type of a network of SAN/LAN or the like connectable by the I/O device, and a network topology connected to the I/O device other than the information of a load, presence/absence of a failure, and a operational state of the I/O device. That is, a restriction is imposed on a network path and a target system which are accessible by an HBA device using an SAN network, or NIC using LAN.

Therefore, there is a case where an access cannot be made even to an I/O device having the same type of a connectable network.

Even when a network path used is changed by preparing plural network paths for respective types of connectable networks and using load information in I/O devices in correspondence with the network paths as in the background art, loads applied on the I/O devices are biased, and therefore, the I/O transfer efficiency is reduced.

For example, in a case where plural computer systems share to use a physical I/O device of an I/O configuration by using a virtualizing technology, although a computer system can control the I/O device that is managed by the corresponding computer system, network paths used cannot be controlled, and therefore, loads applied on the I/O device are biased.

There poses a problem as follows in a computer system integrating SAN and LAN by using an FcoE (Fiber Channel over Ethernet) protocol which is a technology of integrating networks of SAN and LAN.

In the computer system using the FCoE protocol, even when a network path is changed based on loads applied on a total of I/O devices, a load which is applied on a single I/O device differs for each type of a connectable network, and therefore, a concentration of a load for each type of the connectable network cannot be resolved. That is, even in a case where loads are not applied on a total of I/O devices, there is a case where the load is concentrated on a network of either one of SAN and LAN.

In a case where there occurs an access exceeding an entire band which can be used by an I/O device, even when a path used is changed, the I/O transfer efficiency is reduced, and the I/O transfer efficiency is reduced until the access is reduced to be less than a band which can be used by the I/O device.

It is an object of the present invention to resolve the problem described above. That is, in a computer system, there is provided a technology which can shorten I/O processing time by preventing a load from being concentrated on a specific I/O device by controlling flow amounts of I/O devices for respective types of connectable networks.

It is another object of the present invention to provide a technology which can prevent a reduction in an I/O transfer efficiency caused by a deficiency in a band of an I/O device for each type of a connectable network by managing used bands of plural I/O devices by a computer system.

A representative aspect of the present invention is shown as follows. That is, there is provided an I/O device management method in a computer system including a computer, plural I/O devices connected to plural networks having different network configurations, I/O switches assigning the I/O devices to the computer so as to be able to communicate with the networks, and a management computer managing the I/O devices assigned to the computer. The I/O device management method is featured in that the management computer includes a first processor, a first memory connected to the first processor, and a first network interface connected to the first processor, the computer includes a second processor, a second memory connected to the second processor, and a second network interface connected to the second processor, and the method includes a first step of acquiring I/O device configuration information of the I/O device assigned to the computer, and network configuration information of the network connected with the I/O device assigned to the computer by the management computer, a second step of acquiring a flow amount indicating an amount of a data transmitted and received via the I/O device assigned to the computer for each I/O type which is a type of the data transmitted and received via the I/O device by the management computer, a third step of determining the I/O device changing an assignment to the computer based on the flow amount acquired for each of the I/O type, the acquired I/O device configuration information, and the acquired network configuration information by the management computer, and a fourth step of issuing an assignment change instruction for changing the assignment of the determined I/O device to the I/O switch by the management computer.

According to the aspect of the present invention, the I/O transfer efficiency can be increased, since there can be executed the assignment of the I/O device in consideration of the I/O type in the I/O device and the network configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of explaining a configuration of a computer system according to an embodiment of the present invention;

FIG. **2** is a block diagram of explaining a configuration example of a management server according to an embodiment of the present invention;

FIG. **3** is a block diagram of explaining a configuration example of a server according to an embodiment of the present invention;

FIG. **4** is a block diagram of explaining a configuration example of an I/O switch according to an embodiment of the present invention;

FIG. **5** is a block diagram of explaining a configuration example of SVP according to an embodiment of the present invention;

FIG. **6** is an explanatory diagram showing an example of changing an assignment of an I/O device according to an embodiment of the present invention;

FIG. **7** is an explanatory diagram showing an example of changing an assignment of an I/O device according to an embodiment of the present invention;

FIG. **8** is an explanatory diagram showing an example of an I/O switch management table included by a management server according to an embodiment of the present invention;

FIG. **9** is an explanatory diagram showing a server management table included by a management server according to an embodiment of the present invention;

FIG. **10** is an explanatory diagram showing a server I/O configuration information table included by a management server according to an embodiment of the present invention;

FIG. **11** is an explanatory diagram showing a device pool management table included by a management server according to an embodiment of the present invention;

FIG. **12** is an explanatory diagram showing a port management table included by an I/O switch according to an embodiment of the present invention;

FIG. **13** is an explanatory diagram showing an example a state of assigning a physical port and a logical port in an I/O switch according to an embodiment of the present invention;

FIG. **14** is a flowchart of explaining a processing executed by an I/O service management unit included by a management server according to an embodiment of the present invention;

FIG. **15**A is a flowchart of explaining a processing executed by an I/O switch management unit included by a management server according to an embodiment of the present invention;

FIG. **15**B is a flowchart of explaining a processing executed by an I/O switch management unit included by a management server according to an embodiment of the present invention;

FIG. **16** is a flowchart of explaining details of a processing executed by an I/O switch determining unit included by a management server according to an embodiment of the present invention;

FIG. **17** is a flowchart of explaining details of a processing executed by an I/O switch assigning unit included by a management server according to an embodiment of the present invention;

FIG. **18** is a flowchart of explaining details of a processing executed by an I/O switch assignment controlling unit included by SVP according to an embodiment of the present invention;

FIG. **19** is a flowchart of explaining details of a processing executed by a cross bus switch controlling unit included by an I/O switch according to an embodiment of the present invention;

FIG. **20** is a flowchart of explaining details of a processing executed by an I/O device management unit included by a management server according to an embodiment of the present invention;

FIG. **21** is a flowchart of explaining a processing executed by an I/O device flow amount determining unit included by a management server according to an embodiment of the present invention;

FIG. **22** is a flowchart of explaining a processing executed by an I/O device flow amount controlling unit included by a management server according to an embodiment of the present invention;

FIG. **23** is a flowchart of explaining a processing executed by an I/O analyzing unit included by a server according to an embodiment of the present invention;

FIG. **24** is a flowchart of explaining a processing executed by an I/O controlling unit included by a server according to an embodiment of the present invention; and

FIG. **25** is a flowchart of explaining a processing executed by an I/O device performance acquiring unit included by a management server according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An explanation will be given of an embodiment of the present invention in reference to the drawings as follows.

FIG. **1** is a block diagram of explaining a configuration example of a computer system according to an embodiment of the present invention.

A computer system is configured by a management server **101**, a network switch **121**, a server **115**, SVP **119**, an I/O switch **120**, a socket **116**, an I/O device **117**, a storage system **160**, and a network switch **170**.

The management server **101** manages the server **115**, the I/O switch **120**, and the I/O device **117**. A description will be given later of the management server **101** in reference to FIG. **2**.

The server **115** is a computer which executes a prescribed processing. A description will be given later of the server **115** in reference to FIG. **3**.

As shown in FIG. **1**, the server **115** is connected to the management server **101** via the network switch **121**. The server **115** is connected to the I/O switch **120**, and is connected to the I/O device **117** via the socket **116** connected to a port of the I/O switch **120**.

The I/O switch **120** connects the server **115** and the I/O device **117**. The I/O switch **120** manages a logical connection (logical path) between the server **115** and the I/O device **117**. The server **115** and the I/O device **117** are brought into a communicatable state by setting the logical path. In the following, setting of a logical path is described as assigning the I/O device **117** to the server **115**.

A description will be given later of the I/O switch **120** in reference to FIG. **4**.

The I/O device **117** is a device for connecting the server **115** and the storage system **160** or the network switch **170**.

The I/O device **117** is a device for inputting and outputting data outputted from the server **115** and data inputted to the server **115**. As the I/O device **117**, there are conceivable a network interface card (NIC) for connecting to LAN, a host bus adapter (HBA) for connecting to SAN, and CNA (Converged Network Adapter) including FCoE (Fiber Channel over Ethernet) protocol. According to the present embodiment, the I/O device **117** may include an adapter in accordance with a protocol used in communication, and adapters included in the respective I/O devices **117** may differ from each other.

There can be anticipated a reduction and simplification of cable connection, a reduction in a number of adapters necessary for respective hosts, and a reduction in an electric power by including a CNA device by the I/O device **117**.

SVP **119** monitors a state of a hardware included in each server **115**, and controls a power source. A description will be given later of SVP **119** in reference to FIG. **5**.

As shown in FIG. **1**, SVP **119** is connected to the management server **101** via the network switch **121**.

The network switch **121** and the network switch **170** are connected to a network of LAN.

The storage system **160** stores data used by the server **115**. The storage system **160** includes plural disc devices (not illustrated). The storage system **160** can create one or more of a storage area(s) by using plural disc devices, and assign the storage region(s) to respective servers **115**. The storage system **160** may include SSD (Solid State Drive) other than the disc device as a storage medium.

According to the present embodiment, an I/O device pool (not illustrated) is configured from the I/O devices **117** which are not assigned to the server **115**.

FIG. **2** is a block diagram of explaining a configuration example of the management server **101** according to an embodiment of the present invention.

The management server **101** includes a processor **202**, a memory **201**, a disc interface **203**, and a network interface **204**.

The processor **202** executes a program stored in the memory **201**.

The memory **201** stores a program executed by the processor **202**, and information necessary for executing the program.

The memory **201** stores an I/O management unit **102**, an I/O switch management table **111**, a server management table **112**, a server I/O configuration information table **113**, and a device pool management table **114**.

The I/O management unit **102** manages and controls the I/O device **117**. The I/O management unit **102** includes an I/O service management unit **103**, an I/O switch management unit **104**, an I/O device management unit **105**, an I/O switch assignment determining unit **106**, an I/O device flow amount determining unit **107**, an I/O switch assigning unit **108**, an I/O device flow amount controlling unit **109**, and an I/O performance acquiring unit **110**.

The I/O service management unit **103** supervises a processing with regard to the I/O device **117**. The I/O switch management unit **104** or the I/O device management unit **105** starts activation by the I/O management unit **103**. A description will be given later of a processing executed by the I/O service management unit **103** in reference to FIG. **14**.

The I/O switch management unit **104** determines which of an addition processing of the I/O device **117**, or an unassignment processing of the I/O device **117** is to be executed. Here, the addition processing of the I/O device **117** is a processing of newly assigning an I/O device to the server **115**. The unassignment processing of the I/O device **117** is a processing of unassigning the I/O device **117** assigned to the server **115**.

A description will be given later of the processing executed by the I/O switch management unit **104** in reference to FIG. **15**A and FIG. **15**B.

In the following, the addition processing of the I/O device **117** is described as the addition processing, and the unassignment processing of the I/O device **117** is described as the unassignment processing.

The I/O switch assignment determining unit **106** executes the addition processing, and the unassignment processing. A description will be given later of a processing executed by the I/O switch assignment determining unit **106** in reference to FIG. **16**.

The I/O switch assigning unit **108** reflects a result of a processing executed by the I/O switch assignment determining unit **106** to the server management table **112** described later. A description will be given later of a processing executed by the I/O switch assigning unit **108** in reference to FIG. **17**.

The I/O device management unit **105** executes a changing processing of changing the I/O device **117** assigned to the server **115** to other I/O device **117**. A description will be given later of a processing executed by the I/O device management unit **105** in reference to FIG. **20**.

The I/O device flow amount determining unit **107** acquires an amount of data (flow amount) flowing in the I/O device **117**. A description will be given of a processing executed by the I/O device flow amount determining unit **107** in reference to FIG. **21**.

The I/O device flow amount controlling unit **109** determines the I/O device **117** assigned to the server **115**. A description will be given later of a processing executed by the I/O device flow amount controlling unit **109** in reference to FIG. **22**.

The I/O device performance acquiring unit **110** acquires information related to the I/O device **117**. A description will be given later of a processing executed by the I/O device performance acquiring unit **110** in reference to FIG. **25**.

The I/O switch management table **111** stores a connecting state of the I/O switch **120**. A description will be given later of details of the I/O switch management table **111** in reference to FIG. **8**.

The server management table **112** stores information of resources included in the server **115** and information with regard to the flow amount of the I/O device **117** assigned to the server **115**. A description will be given later of details of the server management table **112** in reference to FIG. **9**.

The server I/O configuration information table **113** stores a connecting state of the I/O device **117**. A description will be given later of details of the server I/O configuration information table **113** in reference to FIG. **10**.

The device pool management table **114** stores information with regard to an I/O device pool. A description will be given later of details of the device pool management table **114** in reference to FIG. **11**.

The information stored to the respective tables is transferred to the server **115** by the processor **202** via the network interface **204**.

The disc interface **203** is an interface for connecting to the storage system **160**. For example, HBA is conceivable as the disc interface **203**.

The network interface **204** is an interface for connecting to the network switch **170**. For example, NIC is conceivable as the network interface **204**.

Respective configurations included in the I/O management unit **102** are not limited to packaging shown in FIG. **2**. For example, a configuration summarizing plural functions to one will do. Although an example shown in FIG. **2** includes respective ones of the disc interface **203** and the network interface **204** independently from each other, an adapter may be shared by including CNA, and a configuration communicatable with the server **115** will do.

FIG. **3** is a block diagram for explaining a configuration example of the server **115** according to an embodiment of the present invention.

The server **115** includes a processor **302**, a memory **301**, an I/O switch interface **303**, and BMC (Baseboard Management Controller) **304**.

The processor **302** executes a program stored to the memory **301**.

The memory **301** stores a program executed by the processor **302** and information necessary for executing the program.

The memory **301** stores a virtualizing unit **306** and a guest **305**.

The virtualizing unit **306** creates a virtual server on the server **115**. Specifically, the virtualizing unit **306** creates an environment in which the plural guests **305** are operable. As the virtualizing unit **306**, for example, a hypervisor is conceivable.

The virtualizing unit **306** includes an I/O analyzing unit **125**, and an I/O controlling unit **126**.

The I/O analyzing unit **125** analyzes an I/O request transmitted from the guest **305**, and determines the I/O device **117** which transmits the I/O request. A description will be given later of a processing executed by the I/O analyzing unit **125** in reference to FIG. **23**.

The I/O controlling unit **126** transmits the I/O request transmitted from the guest **305** from the I/O device **117** which is determined by the I/O analyzing unit **125**. A description will be given later of a processing executed by the I/O controlling unit **126** in reference to FIG. **24**.

The guest **305** executes a prescribed processing. The guest **305** includes OS and an application executed on the OS.

Although in an example shown in FIG. **3**, an explanation has been given of a case where the plural guests **305** are operated by the virtualizing unit **306**, for example, there may be constructed a configuration in which OS is stored on the memory **301** instead of the virtualizing unit **306**, and the processor **302** executes the OS. In this case, OS may include functions of receiving an I/O request for an application, and distributing the I/O request.

According to the present embodiment, the I/O request includes an I/O request for the network switch **170** and an I/O request for the storage system **160**. In the following, a type of the I/O request described above is described as I/O type. There may be a type of other I/O request.

The I/O switch interface **303** is an interface for connecting to the I/O switch **120**. The server **115** is connected to the I/O switch **120** via the I/O switch interface **303**, and can use the I/O device **117** connected to the I/O switch **120**. BMC **304** is an interface for connecting to the network switch **121**.

FIG. **4** is a block diagram for explaining a configuration example of the I/O switch **120** according to an embodiment of the present invention.

The I/O switch **120** includes a control processor **402**, a memory **401**, a network interface **403**, a cross bus switch **404**, and a port **407**.

The control processor **402** executes a program stored to the memory **401**.

The memory **401** stores the program executed by the control processor **402** and information necessary for executing the program. The memory **401** stores a cross bus switch controlling unit **405** and a port management table **406**.

The cross bus switch controlling unit **405** executes a control of the cross bus switch **404**. The cross bus switch controlling unit **405** manages an assignment of the port **407** connected to the cross bus switch **404** and the server **115** or the I/O device **117**. The cross bus switch controlling unit **405** issues an assignment change request to the cross bus switch **404**.

The port management table **406** stores a state of assigning the port **407**. A description will be given later of the port management table **406** in reference to FIG. **12**.

The network interface **403** is the interface **403** for connecting to the management server **101**.

The cross bus switch **404** establishes a correspondence between the port **407** and a logical port, and creates an assignment group which manages a correspondence relationship between the port **407** and the logical port. The cross bus switch **404** is connected to the control processor **402**, and the plural ports **407** included in the I/O switch **420**.

The port **407** is an interface for connecting to an external device. According to the present embodiment, the port **407** is connected to the server **115** or the I/O device **117** via the socket **116**.

FIG. **5** is a block diagram for explaining a configuration example of SVP **119** according to an embodiment of the present invention.

SVP **119** includes a processor **602**, a memory **601**, an I/O interface **603**, and BMC **604**.

The processor **602** executes a program stored to the memory **601**.

The memory **601** stores a program executed by the processor **602** and information necessary for executing the program. The memory **601** stores an I/O assignment controlling unit **127**.

The I/O switch assignment controlling unit **127** receives a request of changing the I/O device **117** assigned to the server **115** from the management server **101** and issues an assignment change instruction of the I/O device **117** to the cross bus switch controlling unit **405**.

A description will be given later of a processing executed by the I/O switch assignment controlling unit **127** in reference to FIG. **18**.

The I/O interface **603** is an interface for connecting to a disc device **605** included by the storage system. BMC **604** is an interface for connecting to the network switch **121**. SVP **119** can receive an assignment change request of the I/O device **117** from the management server **101** via BMC **604**.

As shown in FIG. **5**, SVP **119** includes the I/O switch assignment controlling unit **127**. However, the present invention is not limited thereto. For example, there may be constructed a configuration including a function of being able to transmit the assignment change request transmitted from the management server **101** to the I/O switch **120** by the server **115**.

FIG. **6** and FIG. **7** are explanatory diagrams showing an example of changing an assignment of the I/O device **117** according to an embodiment of the present invention.

FIG. **6** shows a configuration before changing an assignment of the I/O device **117**. FIG. **7** shows a configuration after changing an assignment of the I/O device **117**.

According to an example shown in FIG. **6**, plural servers **115-1** through **115-4** are connected to plural I/O switches **120-1** through **120-2**. The I/O switches **120-1** through **120-2** are respectively connected to I/O devices **117-1** through **117-8** via sockets **116-1** through **116-8** connected to the respective ports **407** of the I/O switches **120-1** through **120-2**.

According to the example shown in FIG. **6**, the I/O device **117** including NIC as an adapter and the I/O device **117** including HBA as an adapter are mixed. The I/O device **117** including NIC is connected to LAN via the network switch **170**. The I/O device **117** including HBA is connected to the storage system **160** included in SAN.

The storage system **160** includes one or more of the disc device(s) **605**. The servers **115-1** through **115-4** read data from the disc device **605** and write data to the disc device **605**.

The I/O device **117** including NIC as an adapter holds an MAC address as an identifier for uniquely identifying the I/O device **117**. The I/O device **117** including HBA as an adapter holds WWN (World Wide Name) as an identifier for uniquely identifying the I/O device **117**.

Also, the I/O device **117** including NIC as an adapter is assigned with a logical port for the server **115**. Here, assignment of the logical port indicates that the I/O switch **120** is set with a virtually defined logical path.

According to the example shown in FIG. **6**, the I/O switch **120-1** connects the I/O devices **117-1** and **117-3** including NIC as the adapters via the sockets **116-1** and **116-2**. The I/O devices **117-1** and **117-3** are connected to the network switch **170**.

The I/O switch **120-1** connects the I/O devices **117-2** and **117-4** including HBA as the adapters via the sockets **116-2** and **116-4**. The I/O devices **117-2** and **117-4** are connected to the storage system **160** included in SAN.

The I/O switch **120-2** connects the I/O devices **117-5** and **117-7** including NIC as the adapters via the sockets **116-5** and **116-7**. The I/O devices **117-5** and **117-7** are connected to the network switch **170**.

The I/O switch **120-2** connects the I/O devices **117-6** and **117-8** including HBA as the adapters via the sockets **116-6** and **116-8**. The I/O devices **117-6** and **117-8** are connected to the storage system **160** included in SAN.

According to the example shown in FIG. **6**, the servers **115-1** and **115-2** are assigned with the single I/O device **117-5**. The servers **115-1** and **115-2** are brought into a state of being accessible to LAN via the network switch **170** connected to the I/O device **117-5**.

In this case, the single I/O device **117-5** is assigned with the two servers **115-1** and **115-2**, and therefore, a large communication load is applied on the single I/O device **117-5**. Therefore, a usable band of the I/O device **117-5** becomes deficient, and there is a possibility of bringing about an I/O delay in the servers **115-1** and **115-2**.

That is, in a case where either one server **115** of the two servers **115-1** and **115-2** transmits and receives a large amount of data, the usable band of the I/O device **117-5** becomes deficient, and there is a possibility that the other server **115** cannot access to the network switch **170** via the I/O device **117-5**.

A similar problem is posed with regard to the I/O device **117** including HBA as the adapter. The similar problem is posed with regard to the I/O device **117** including CNA as the adapter.

It is conceivable to change the I/O devices **117** used for respective I/O requests in order to resolve the problem described above. However, in a computer system connectable to different networks, an IP network communication used in NIC and a fiber channel communication used in HBA are mixed. Therefore, in the I/O device **117** having different processable I/O types, connected networks differ from each other, and therefore, there is a possibility that a target of an access destination of I/O differs.

Therefore, the problem described above cannot be resolved by simply changing setting of the logical path in the I/O switch **120**. That is, it is necessary to take communication paths of all of networks into a consideration in order to resolve the problem described above.

FIG. **7** is a diagram showing a state after changing the assignment of the I/O device **117** by applying the present invention.

An example shown in FIG. **7** indicates a state where the I/O device **117** assigned to either one of the server **115-1** and the server **115-2** is changed from the I/O device **117-5** to the I/O device **117-7**.

According to the present invention, in a case of bringing about an IP network communication from the servers **115-1** and **115-2** to the network switch **170**, a data amount (flow amount) processed by the I/O device **117-5** is periodically measured, and an I/O request is transmitted to the I/O device **117** equivalent to the assigned I/O device **117-5** for each I/O request. Thereby, a flow amount in each I/O device **117** is controlled. Here, an equivalence of the I/O device **117** indicates that the type of the I/O device **117** stays the same. That is, it is indicated that the adapter included in the I/O device **117** belongs to the same type.

According to the present invention, the occurrence of the I/O delay in the server **115** assigned with the I/O device **117** can be prevented by controlling the flow amount of the I/O device **117**.

According to the present invention, in a case of selecting the I/O device **117** assigned to the server **115**, a consideration is given to respective communication paths of LAN and SAN.

A case of LAN is delimited by a physical connection, a virtual network segment of setting VLAN (Virtual LAN). Therefore, it is necessary to select the I/O device **117** communicatable with a target of an access destination for each I/O request.

Also in a case of FC communication, there is conceivable a case where a state of assigning WWN held by the I/O device **117** and LU (Logical Unit) included in the storage system **160** is set by the storage system, and a virtual connection path is set in the I/O switch **120** by zoning setting included in a device included in an FC network.

That is, there is a case where the server **115** cannot access to an I/O device which is not set with the logical path. Therefore, it is necessary to select the I/O device **117** communicatable with a target of an access destination for each I/O request in consideration of a network topology.

In a case where bands of all the I/O devices **117** assigned to the server **115** are deficient, it is necessary to add an assignment of the I/O device **117** in order to prevent a delay of I/O.

According to the present invention, the I/O transfer efficiency of the server **115** can be increased by controlling a flow amount of an I/O device connected to the I/O switch **120** under an environment where plural network topologies which can be connected by the I/O device **117** are present.

The I/O transfer efficiency is increased by managing the flow amount of the I/O device **117** for each I/O type (LAN/SAN) and pertinently changing the assignment of the I/O device **117** to the server **115**.

Hereinafter, an explanation will be given of a management table which is necessary for embodying the present invention.

FIG. **8** is an explanatory diagram showing an example of the I/O management table **111** included by the management server **101** according to an embodiment of the present invention.

The I/O switch management table **111** stores information of the server **115** and the I/O device **117** which are connected to the ports of the I/O switch **120**. That is, the I/O switch management table **111** stores information of the server **115** and the I/O device **117** physically connected to the I/O switch **120**.

The I/O switch management table **111** includes an I/O switch identifier **1111**, a port number **1112**, a connection destination **1113**, a connection destination identifier **1114**, a state **1115**, a consumed band rate **1116**, a band restriction range **1117**, and a sharing **1118**.

The I/O identifier **1111** is an identifier for uniquely identifying the I/O switch **120** in the computer system.

The port number **1112** is an identification number for identifying the port **407** of the I/O switch **120** in correspondence with the I/O identifier **1111**. The port number **1112** is a number corresponded to the socket **116** connected to the port **407** of the I/O switch **120**.

The connection destination **1113** is a piece of information indicating a type of the server **115** or the I/O device **117** connected to the port **407** in correspondence with the port number **1112**.

For example, in a case of connecting the I/O device **117** including NIC as an adapter to the port **407**, "NIC" is stored. In a case of connecting the I/O device **117** including NBA as an adapter to the port **407**, "HBA" is stored. In a case of connecting the server **115** to the port **407**, "host" is stored. In a case of connecting the I/O device **117** including CAN as an adapter to the port **407**, "CNA" is stored.

The connection destination identifier **1114** is an identifier for identifying the server **115** or the I/O device **117** in correspondence with the connection destination **1113**. Specifically, in a case of the connection destination **1113** is "NIC", an MAC address is stored. In a case where the connection destination **1113** is "HBA", WWN is stored. In a case where the connection destination **1113** is "host", a host name is stored. In a case where the connection destination **1113** is "CNA", an MAC address is stored.

The state **1115** is a piece of information indicating a state of the server **1115** or the I/O device **117** in correspondence with the connection destination **1113**. The state **1115** stores a piece of information stating that the state **1115** is a failure state or a normal state. The management server **101** can grasp the state of the server **1115** or the I/O device **117** in correspondence with the connection destination **1113** based on the state **1115**.

The consumed band rate **1116** is a piece of information indicating the consumed band rate of the server **115** or the I/O device **117** in correspondence with the connection destination **1113**. That is, the consumed band rate **1116** indicates a piece of information of a band which is actually used in a band which is usable for the server **115** or the I/O device **117**. In a case where the connection destination **1113** is "CNA", the consumed band rate **1116** stores values for the respective I/O types, that is, for respective LAN's and respective SAN's.

The band restriction range **1117** is a piece of information indicating a restriction range of the consumed band rate which is set to the I/O device **117** in a case where the connection destination **1113** is the I/O device **117**. Specifically, the band restriction range **1117** stores a lower limit value and an upper limit value of the consumed band rate.

Incidentally, the band restriction range **1117** may store either one of the upper limit value of a band to be restricted or the lower limit value of the band to be restricted.

The management server **101** determines whether the I/O device **117** assigned to the server **115** is added or deleted based on the consumed band rate **1116** and the band restriction range **117**.

The sharing **1118** indicates whether plural servers **115** can share to use the I/O device **117** in a case where the connection destination **1113** is the I/O device **117**. That is, the sharing **1118** stores a piece of information indicating whether it is authorized to set plural logical paths to the single I/O device **117**. The sharing **1118** is a piece of information which is used in a case where the specific server **115** is made to occupy to use the I/O device **117**.

FIG. **9** is an explanatory diagram showing the server management table **112** included by the management server **101** according to an embodiment of the present invention.

The server management table **112** stores a piece of information of a resource included in the server **115** which is a management object, and a flow amount controlling state.

The server management table **112** includes a server identifier **1121**, a processor configuration **1122**, a memory capacity **1123**, an I/O definition **1124**, and a service type **1125**.

The server identifier **1121** is an identifier for identifying the server **115** which is a management object.

The processor configuration **1122** is a piece of configuration information of the processor **302** included by the server **115** in correspondence with the server identifier **1121**. The memory capacity **1123** is a capacity of the memory **301** included by the server **115** in correspondence with the server identifier **1121**.

The I/O definition **1124** is an identifier for identifying the I/O definition. Here, the I/O definition is a definition of a logical path in the server **115**. The I/O definition is configured by a piece of information of the logical port which is set in the I/O switch **120**. A piece of information with regard to the I/O definition is stored to the server I/O definition table **113**. A description will be given later of a specific content of the I/O definition in reference to FIG. **10**.

The service type **1125** is a piece of information indicating a type of an assignment changing processing of the I/O device **117**.

Specifically, in a case where the service type **1125** is "0", there is executed a processing for changing an assignment of the I/O device **117** connected to the I/O switch **120**. In a case where the service type **1125** is "1", there is executed a processing of adding or deleting the I/O device connected to the I/O switch **120**.

FIG. **10** is an explanatory diagram showing the server I/O configuration information table **113** included by the management server **101** according to an embodiment of the present invention.

The server I/O configuration information table **113** stores a piece of configuration information of the I/O device **117**.

The server I/O configuration information table **113** includes a definition **1138**, an I/O identifier **1131**, a port number **1132**, a connection device **1133**, a communication destination **1134**, and an importance degree **1135**.

The definition **1138** is an identifier for identifying an I/O definition.

The I/O switch identifier **1131** is an identifier for identifying the I/O switch **120**. Incidentally, the I/O switch identifier **1131** is the same as the I/O identifier **1111** included in the I/O switch management table **111**.

The port number **1132** is an identification number for identifying the port **407** of the I/O switch **120** in correspondence with the I/O switch identifier **1131**. Incidentally, the port number **1132** is the same as the port number **1112** included in the I/O management table **111**.

The connection device **1133** is a piece of information indicating a type of the I/O device **117** connected to the port **407** in correspondence with the port number **1112**. That is, the connection device **1133** indicates a type of an adapter included by the I/O device **117**. For example, in a case where CNA is connected to the port **407** of the I/O switch **120**, the connection device **1133** stores "CNA".

The communication destination **1134** is a piece of information of a communication destination connected to the I/O device **117** in correspondence with the connection device **1134**. That is, the communication destination **1134** is a piece of information of a network which can be accessed via the I/O device **117** in correspondence with the connection device

1133. The communication destination 1134 is used when the I/O device 117 which can access to the same network is retrieved.

The importance degree 1135 is an importance degree set to the I/O device 117. Specifically, in a case where an assignment of the I/O device 117 is changed, an assignment of the I/O device 117 having an importance degree of "High" is made not to be changed, and with regard to the I/O device 117 having the importance degree 1135 of "Low", the assignment of the I/O device 117 is made to be able to be changed predominantly. That is, in a case where the importance degree 1135 is "High", the server 115 transmits and receives I/O by predominantly using the I/O device 117. On the other hand, with regard to the I/O device 117 having the importance degree 1135 of "Low", it is shown that the assignment of the I/O device 117 can predominantly be changed.

For example, in a case where I/O for the certain server 115 is intended to be transmitted and received via the specific I/O device 117, "High" is stored to the importance degree 1135 of the I/O device 117.

The importance degree 1135 is used when the I/O device 117 which is used by the I/O device flow amount controlling unit 109 is determined.

According to the present embodiment, the connection destination 1113, the connection destination identifier 1114, and the connection device 1133 are pieces of information in correspondence with the I/O type. The communication destination 1134 is a piece of information in correspondence with a network topology.

FIG. 11 is an explanatory diagram showing the device pool management table 114 included by the management server 101 according to an embodiment of the present invention.

The device pool management table 114 stores a piece of information with regard to an assigned state of the I/O device 117 connected to the I/O switch 120.

The device pool management table 114 includes an I/O identifier 1141, a port number 1142, an assigned state 1143, and a device pool assignment 1144.

The I/O switch identifier 1141 is an identifier for identifying the I/O switch 120. The I/O switch identifier 1141 is the same as the I/O identifier 1111 of the I/O switch management table 111.

The port number 1142 is an identification number for identifying the port 407 of the I/O switch 120 in correspondence with the I/O identifier 1141. Incidentally, the port number 1142 is the same as the port number 1112 included in the I/O switch management table 111.

The assigned state 1143 is a piece of information indicating an assigned state of the I/O device 117 connected to the port 407 in correspondence with the port number 1142. That is, the assigned state 1143 is a piece of information indicating whether the I/O device 117 connected to the port 407 is assigned to at least one or more of the server(s) 115.

In a case where the I/O device 117 is assigned to one or more of the server(s) 115, the assigned state 1143 stores "assigned". In a case where the I/O device 117 is not assigned to any of the servers 115, the assigned state 1143 stores "not assigned yet".

The assigned state 1143 is updated when the assignment of the I/O device 117 to the server 115 is changed. The I/O device 117 in which the assigned state 1143 is "not assigned yet" becomes a candidate of the I/O device 117 which is newly assigned to the server 115.

The device pool assignment 1144 is an identifier for identifying a device pool which is configured by the plural I/O device 117. Here, the device pool is configured by one or more of the I/O device(s) 117 in which the assigned state 1143 is "not assigned yet".

FIG. 12 is an explanatory diagram showing a port management table 406 included by the I/O switch 120 according to an embodiment of the present invention.

The port management table 406 stores a correspondence relationship between plural physical ports (ports 407) included by the I/O switch 120 and a logical connection (logical port).

The port management table 406 includes a physical port number 4061, an assigned group 4062, and a logical port number 4063.

The physical port number 4061 is an identification number for identifying the port 407 included by the I/O switch 120, and is the same as the port number 1112 of the I/O switch management table 111.

The assigned group 4062 is an identifier for identifying an assigned group configured by the plural logical ports. According to the present embodiment, the assignment of the I/O device 117 to the server 115 is managed by a unit of the assigned group (refer to FIG. 13).

The physical port (port number 407) is logically connected to the logical port. Here, the logical port indicates a virtual port set in the I/O switch 120.

The logical port number 4063 is an identifier for identifying the logical port set in the I/O switch 120. The logical port number 4063 stores an identifier of the logical port that is connected to the physical port (port 407) in correspondence with the physical port number 4061.

FIG. 13 is an explanatory diagram showing an example of a state of assigning the physical port and the logical port in the I/O switch 120 according to an embodiment of the present invention.

As shown in FIG. 13, the I/O switch 120 includes 8 of the ports 407.

A port 0 (407) is connected with an I/O device 0 (117), a port 1 (407) is connected with an I/O device 1 (117), a port 2 (407) is connected with an I/O device 2 (117), and a port 3 (407) is connected with an I/O device 3 (117).

A port 4 (407) is connected with a server 1 (115), and a port 7 is connected with a server 2 (115).

A logical port 0 (1501-1) connects the port 4 (407) and the port 0 (407), and a logical port 1 (1051-2) connects the port 4 (407) and the port 1 (407). The logical port 0 (1501-3) connects the port 7 (407) and the port 2 (407), and the logical port 1 (1051-4) connects the port 7 (407) and the port 3 (407).

An assigned group 1502 is created by establishing a correspondence between the port 407 included by the I/O switch 120 and the logical port 1501.

According to an example shown in FIG. 13, an assigned group 1502-1 and an assigned group 1502-2 are created. An access is set not to be able to be made between the ports 407 of the different assigned groups 1502.

A state of an assignment as shown in FIG. 13 is stored to the port management table 406.

FIG. 14 is a flowchart for explaining a processing executed by the I/O service management unit 103 included by the management server 101 according to an embodiment of the present invention.

The I/O service management unit 103 executes processes explained below based on the service type 1125 of the server 115 which is a management object (hereinafter, also referred to as the object server 115). A description will be given later of a method of determining the object server 115 in reference to FIG. 25.

The I/O service management unit **103** acquires the service type **1125** of the object server **115** from the server management table **112** when the processes are started (step **1031**).

The I/O service management unit **103** determines the service type of the object server **115** based on the acquired service type **1125** (step **1032**).

In a case where the acquired service type **1125** is “0”, it is determined that the service type of the object server **115** is a device. In a case where the acquired service type **1125** is “1”, it is determined that the service type of the object server **115** is a switch.

In a case where it is determined that the service type of the object server **115** is a switch, the I/O service management unit **103** calls the I/O device management unit **105** (step **1033**), and the processes are finished (step **1035**). The called I/O device management unit **105** executes processes for changing the assignment of the I/O device **117**.

In a case where it is determined that the service type of the object server **115** is a device, the I/O service management unit **103** calls the I/O switch management unit **104** (step **1034**), and the processes are finished (step **1035**). The called I/O switch management unit **104** executes an adding processing or an unassigning processing.

In a case where there are the plural object servers **115**, the I/O service management unit **103** repeatedly executes the processes described above (step **1031** through step **1035**) for all of the object servers **115**.

The I/O service management unit **103** may execute the processes described above periodically, or execute the processes described above after receiving an instruction from an operator of the management server **101**. Or, the I/O service management unit **103** may execute the processes described above with the call from the I/O device performance acquiring unit **110** as a momentum.

FIG. **15**A and FIG. **15**B show a flowchart for explaining a processing executed by the I/O switch management unit **104** included by the management server **101** according to an embodiment of the present invention.

The I/O switch management unit **104** is called from the I/O service management unit **103** (step **1034**). The I/O switch management unit **104** executes either one processing of the adding processing or the unassigning processing.

The I/O switch management unit **104** specifies the I/O device **117** assigned to the object server **115** in reference to the server management table **112** and the server I/O configuration information table **113** (step **1041**).

Specifically, the I/O switch management unit **104** acquires the I/O definition **1124** from entry of the server identifier **1121** in correspondence with the object server **115** in reference to the server management table **112**.

The I/O switch management unit **104** acquires a piece of information of the definition **1137** in agreement with the acquired I/O definition **1124** in reference to the server I/O configuration information table **113** based on the acquired I/O definition **1124**. That is, there are acquired the I/O switch identifier **1131**, the port number **1132**, the connection device **1133**, the communication destination **1134**, and the importance degree **1135**.

Thereby, the I/O switch management unit **104** can specify the I/O device **117** assigned to the object server **115**.

The I/O switch management unit **104** acquires a piece of information with regard to the specified I/O device **117** in reference to the I/O switch management table **114** based on the piece of information acquired at step **1041** (step **1042**).

Specifically, the I/O switch management unit **104** acquires the consumed band rate **1116** and the band restriction range **1117** with regard to the specified I/O device **117** in reference to the I/O switch management table **111** based on the acquired I/O identifier **1131** and the acquired port number **1132**.

The I/O switch management unit **104** acquires the consumed band rates **1116** and the band restriction ranges **1117** of all of the I/O devices **117** specified at step **1041**.

The I/O switch management unit **104** determines whether the consumed band rate **1116** is within the band restriction range **1117** for each I/O device **117** by using the acquired consumed band rate **1116** and the acquired band restriction range **1117** (step **1043**).

That is, it is determined whether the total consumed bands in the single I/O device **117** are included within a prescribed range indicated by the band restriction range **1117**. The determining processing is executed in consideration of the consumed bands of the total of the I/O devices **117**.

For example, in a case of the I/O device **117** including CNA as an adapter, the determining processing is executed based on a total consumed band in combination with a consumed band in SAN and a consumed band in LAN.

The I/O switch management unit **104** determines whether the consumed band rate **1116** of the I/O device **117** is larger than the upper limit value of the band restriction range **1117** based on a result of the determining processing at step **1043** (step **1044**).

In a case where it is determined that the consumed band rate **1116** of the I/O device **117** is larger than the upper limit value of the band restriction range **117**, the I/O switch management unit **104** issues an assign-add instruction of the I/O device **117** to the I/O switch assignment determining unit **106** (step **1046**), and proceeds to step **1047**.

This is for resolving a deficiency in the band of the I/O device **117** assigned to the object server **115**.

The assign-add instruction includes a piece of information with regard to the I/O device **117** having the deficient band. Specifically, the assign-add instruction includes the I/O switch identifier **1131**, the port number **1132**, the connection device **1133**, the communication destination **1134**, and the connection destination **1113**. The assign-add instruction may include other information of the importance degree **1135**.

In a case where it is determined that the consumed band rate **1116** of the I/O device **117** is equal to or less than the upper limit value of the band restriction range **1117**, the I/O switch management unit **104** determines whether the consumed band rate **1116** is smaller than the lower limit value of the band restriction range **1117** (step **1045**).

In a case where it is determined that the consumed band rate **1116** is smaller than the lower limit value of the band restriction range **1117**, the I/O switch management unit **104** issues an unassignment instruction of the I/O device **117** to the I/O switch assignment determining unit **106** (step **104**D), and proceeds to step **1047**.

This is for effectively utilizing the I/O device **117** by unassigning the I/O device **117** having an excess band.

The unassignment instruction includes a piece of information with regard to the I/O device **117** of the unassignment object. Specifically, the unassignment instruction includes the I/O switch identifier **1131**, the port number **1132**, the connection device **1133**, the communication destination **1134**, and the connection destination **1113**. The unassignment instruction may include other information of the importance degree **1135**.

In a case where it is determined that the consumed band rate **1116** is equal to or more than the lower limit value of the band restriction range **1117**, the I/O switch management unit **104** proceeds to step **104**B.

That is, in a case where it is determined that the consumed band rate **1116** is within a range of the band restriction range

1117, excess and deficiency are not brought about in the band of the I/O device 117. Therefore, it is not necessary to change the assignment of the I/O device 117.

The I/O switch management unit 104 calls the I/O switch assignment determining unit 106 after issuing the assign-add instruction or the unassignment instruction (step 1047).

The called I/O switch assignment determining unit 106 executes a processing based on a piece of information included in the assign-add instruction or the unassignment instruction. A description will be given later of details of the processing executed by the I/O switch assignment determining unit 106 in reference to FIG. 16.

The I/O switch management unit 104 continues waiting until a result of the processing of the I/O switch assignment determining unit 106 is noticed.

In a case where the result of the processing from the I/O switch assignment determining unit 106 (refer to FIG. 16) is noticed, the I/O switch management unit 104 determines whether the assignment of the I/O device 117 can be changed based on the processing result (refer to FIG. 16) (step 1048). That is, it is determined whether either one of the assign-add processing or the unassignment processing can be executed.

In a case where it is determined that the assignment of the I/O device 117 cannot be changed, the I/O switch management unit 104 proceeds to step 104B.

In a case where it is determined that the assignment of the I/O device 117 can be changed, the I/O switch management unit 104 calls the I/O switch assignment unit 108 (step 1049).

At this occasion, the I/O switch management unit 104 notices the processing result of the I/O switch assignment determining unit 106 (refer to FIG. 16) to the I/O switch assigning unit 108.

The I/O assigning unit 108 executes a processing based on the processing result of the I/O switch assignment determining unit 106 (refer to FIG. 16). A description will be given later of details of the processing executed by the I/O switch assigning unit 108 in reference to FIG. 17.

The I/O switch management unit 104 continues waiting until the processing result of the I/O assigning unit 108 is noticed.

In a case where the processing result is noticed from the I/O switch assigning unit 108, the I/O switch management unit 104 updates the I/O switch management table 111 based on the processing result (step 104A).

For example, in a case where the assign-add instruction is executed, there are updated the state 1115 of entry in correspondence with a port to which a newly assigned I/O device 117 is connected, the consumed band rate 1116, the band restriction range 1117, and the sharing 1118. A similar processing is executed also in a case where the unassignment instruction is executed.

Thereafter, the I/O switch management unit 104 calls the I/O device management unit 105 (step 104B), and finishes the processes (step 104C).

In a case where only one of the upper limit or the lower limit value is stored to the band restriction range 1117, only either one of step 1044 or step 1045 may be executed.

FIG. 16 is a flowchart for explaining details of a processing executed by the I/O switch assignment determining unit 106 included in the management server 101 according to an embodiment of the present invention.

The I/O switch assignment determining unit 106 is called from the I/O switch management unit 104 (step 1047). The I/O switch assignment determining unit 106 changes a logical connection between the I/O device 117 and the server 115 which are connected to the I/O switch 120.

The I/O switch assignment determining unit 106 determines which of an assign-add instruction or an unassignment instruction is an instruction issued from the I/O switch management unit 104 (step 1061).

In a case where it is determined that the instruction issued from the I/O switch management unit 104 is the unassignment instruction, the I/O switch assignment determining unit 106 determines whether the I/O device 117 which is an unassignment object can be assigned based on a piece of information included in the unassignment instruction (step 1062).

Specifically, the I/O switch assignment determining unit 106 determines whether two or more of the I/O devices 117 which are equivalent to the I/O device 117 that is the unassignment object are assigned to the server 115 which is assigned with the I/O device 117 of the unassignment object.

Here, the equivalent I/O device 117 indicates the I/O device 117 in which an adapter included in the I/O device 117 stays the same and a network of the communication destination of the I/O device 117 of the unassignment object stays the same. That is, the equivalent I/O device 117 indicates the I/O device 117 in which the connection device 1133 and the communication destination 1134 of the server I/O configuration information table 113 stay the same.

At step 1062, the following processing is executed.

First, the I/O switch assignment determining unit 106 extracts the connection device 1133 and the communication destination 1134 from the unassignment instruction of the I/O device 117.

Next, the I/O switch assignment determining unit 106 determines whether two or more of the I/O devices equivalent to the I/O device 117 of the unassignment object are assigned to the server 115 in reference to the server I/O configuration information table 113 based on the connection device 1133 and the communication destination 1134 which are extracted.

This is executed for determining whether an accessible communication destination is reduced by deleting the I/O device 17.

As a method of specifying the I/O device 117 assigned to the server 115 at step 1062, a method the same as that at step 1041 may be used, or, the processing result at step 1041 may be used.

In a case where it is determined that two or more of the I/O devices 117 which are equivalent to the I/O device 117 to be deleted are not assigned to the server 115, the I/O switch assignment determining unit 106 finishes the processes (step 1068).

In a case where it is determined that two or more of the I/O devices 117 which are equivalent to the I/O device 117 to be deleted are assigned to the server 115, the I/O switch assignment determining unit 106 acquires a piece of information for unassigning the I/O device 117, and proceeds to step 1067.

The piece of information for unassigning the I/O device 117 includes the identifier (I/O switch identifier 1131) of the I/O switch 120 which connects the I/O device 117 of the unassignment object, and the identifier of the port (port number 1132) to which the I/O device 117 of the unassignment object is connected.

At step 1061, in a case where it is determined that an instruction issued from the I/O switch management unit 104 is an assign-add instruction, the I/O assignment determining unit 106 acquires a piece of information of the I/O device 117 in an unassigned state in reference to the device pool management table 114 (step 1063).

Specifically, the I/O switch assignment determining unit 106 retrieves the I/O device 117 which stores the identifier of the device pool at the device pool assignment 1144 and the I/O device 117 in which the sharing is possible in the sharing state **1118**. The I/O switch assignment determining unit **106** acquires the I/O switch identifier **1141** and the port number **1142** of corresponding entry.

The I/O switch assignment determining unit **106** acquires the connection destination **1113**, the state **1115**, and the sharing **1118** in reference to the I/O switch management table **111** based on the I/O switch identifier **1141** and the port number **1142** which are acquired. The I/O switch assignment determining unit **106** acquires the connection device **1133** and the communication destination **1134** in reference to the server I/O configuration information table **113** based on the I/O switch identifier **1141** and the port number **1142** which are acquired.

The I/O switch assignment determining unit **106** determines whether there is present the I/O device **117** which can be assigned to the I/O switch **120** to which the object server **115** is connected (step **1064**).

Specifically, the I/O switch assignment determining unit **106** executes the following processing based on a piece of information acquired at step **1063**.

The I/O switch assignment determining unit **106** determines whether the state **1115** of the I/O device **117** in a not-assigned-yet state is "normal". In a case where there is (are) one or more of the I/O device(s) **117** in which the state **1115** of the I/O device **117** in the not-assigned-yet state is "normal", it is determined that the I/O device **117** to be assigned is present.

In a case where it is determined that there is (are) one or more of the I/O device(s) in which the state **1115** is "normal", the I/O switch assignment determining unit **106** determines whether there is present the I/O device **117** in which the I/O type, and the network of the communication destination in the I/O device **117** having a deficient band stays the same.

The I/O switch assignment determining unit **106** extracts the connection destination **1113**, the connection device **1133**, and the communication destination **1134** which are included in the assign-add instruction.

The I/O switch assignment determining unit **106** determines whether all of the connection destination **1113**, the connection device **1133**, and the communication destination **1134** which are extracted are the same as the connection destination **1113**, the connection device **1133**, and the communication destination **1134** which are acquired at step **1063**.

In a case where all of the connection destination **1113**, the connection device **1133**, and the communication destination **1134** which are extracted are the same as the connection destination **1113**, the connection device **1133**, and the communication destination **1134** which are acquired at step **1063**, it is determined that there is the assignable I/O device **117**.

The above-described are the processes executed at step **1064**.

In a case where it is determined that the assignable I/O device **117** is not present at the I/O switch **120** to which the object server **115** is connected, the I/O switch assignment determining unit **106** notices an error to the I/O switch management unit **104** (step **1068**), and finishes the processes (step **1068**).

The error may be noticed to an operator of the management server **101**. As a method of noticing the error, for example, there is conceivable a method of noticing the operator of the management server **101** that the I/O device **117** which can be assigned to the I/O switch **120** is not present.

In a case where it is determined that the I/O device **117** assignable to the I/O switch **120** is present, the I/O switch assignment determining unit **106** determines the I/O device **117** assigned to the server **115** (step **1065**). The I/O switch assignment determining unit **106** acquires a piece of information for newly assigning the I/O device **117**.

In a case where there are plural assignable I/O devices **117**, there is conceivable a method of selecting the I/O device **117** having the least consumed band rate **1116** of the I/O switch management table **111**. There may be a method of assigning the I/O devices **117** successively from the I/O devices **117** having the smaller port numbers **1112**.

The piece of information for newly assigning the I/O device **117** includes the identifier (I/O switch identifier **1141**) of the I/O switch **120** to which the assigned I/O device **117** is connected, and the identifier (port number **1142**) of the port to which the I/O device **117** is connected.

The I/O switch assignment determining unit **106** updates the device pool management table **114** (step **1067**), and finishes the processes (step **1068**).

Specifically, the assignment state **1143** and the device pool assignment **1144** are updated.

For example, the I/O switch assignment determining unit **106** changes the assignment state **1143** of the port to which the unassigned I/O device **117** is connected is changed to "not assigned yet", and the identifier of the device pool is stored to the device pool assignment **1144**. The updating is carried out similarly also in the assign-add processing.

The I/O switch assignment determining unit **106** notices the processing result to the I/O switch management unit **104**.

Specifically, there is noticed either one of a notice stating that the assignment of the I/O device **117** is not changed or a notice stating that the assignment of the I/O device **117** can be changed.

Either one of the assign-add instruction or the unassignment instruction is included in the notice stating that the assignment of the I/O device **117** can be changed. An assign-add request includes the I/O switch identifier **1141** and the port number **1142**. The unassignment instruction includes the I/O switch identifier **1131** and the port number **1132**.

At step **1048**, the I/O switch management unit **104** determines that the assignment of the I/O device **117** can be changed in a case where either one of the assign-add instruction or the unassignment instruction is included in the processing result.

FIG. **17** is a flowchart for explaining details of the processes executed by the I/O switch assigning unit **108** included by the management server **101** according to an embodiment of the present invention.

The I/O switch assigning unit **108** is called from the I/O switch management unit **104** (step **1049**). The I/O switch assigning unit **108** transmits an assignment change request of the I/O device **117** based on the processing result of the I/O switch assignment determining unit **106**.

The I/O switch assigning unit **108** calls the I/O switch assignment controlling unit **127** of SVP **119** (step **1081**). The I/O switch determining unit **108** transmits the assignment change request of the I/O device **117** including the processing result of the I/O switch assignment determining unit **106** to the I/O switch assignment controlling unit **127**.

A description will be given later of details of processes executed by the I/O switch assignment controlling unit **127** in reference to FIG. **18**.

The I/O switch assigning unit **108** continues waiting until the processing result of the I/O switch assignment controlling unit **127** is noticed.

In a case where the processing result is noticed from the I/O switch assignment controlling unit **127**, the I/O switch assigning unit **108** determines whether the server management table **112** is updated (step **1082**).

Specifically, the I/O switch assigning unit **108** determines whether the I/O definition **1124** of the server management table **112** is changed. The determination can be determined based on the processing result noticed from the I/O switch assignment controlling unit **127**.

In a case where it is determined that the server management table **112** is not updated, the I/O switch assigning unit **108** finishes the processes (step **1084**).

In a case where it is determined that the server management table **112** is updated, the I/O switch assigning unit **108** updates the server management table **112** (step **1083**), and finishes the processes (step **1084**).

In the processing, the I/O definition **1124** of the server management table **112** is updated. For example, a new definition is changed, added, or deleted for the I/O definition **1124**.

FIG. **18** is a flowchart for explaining details of processes executed by the I/O switch assignment controlling unit **127** included by SVP **119** according to an embodiment of the present invention.

The I/O assignment controlling unit **127** is called from the I/O switch assigning unit **108** (step **1081**). The I/O switch assignment controlling unit **127** changes the assignment of the physical port (port **407**) of the I/O switch **120** for the object server **115**.

The I/O switch assignment controlling unit **127** issues the assignment change instruction of the I/O device **117** to the cross bus switch controlling unit **405** of the I/O switch **120** based on the assignment change request of the I/O device **117** received from the I/O switch assigning unit **108** (step **1271**).

In a case where an assign-add instruction is included in a processing result of the I/O switch assignment determining unit **106**, the I/O switch assignment controlling unit **127** specifies the I/O switch **120** at a notice destination of the assignment change instruction based on the I/O switch identifier **1141** included in the processing result. The I/O assignment controlling unit **127** issues the assign-add instruction including the port number **1142** included in the processing result to the specified I/O switch **120** as the assignment change instruction.

In a case where the unassignment instruction is included in the processing result of the I/O switch assignment determining unit **106**, the I/O assignment controlling unit **127** executes a processing similar to the above-described processing by using the I/O switch identifier **1131** and the port number **1132** included in the processing result. In this case, the unassignment instruction including the port number **1132** is issued to the specified I/O switch **120** as the assignment change instruction.

The I/O switch controlling unit **127** updates the server I/O configuration information table **113** (step **1272**), and finishes the processing (step **1273**).

For example, in a case where the new I/O device **117** is assigned, new entry is added to the server I/O configuration information table **113**, and respective pieces of information are stored to the entry. In a case where the I/O device **117** is unassigned, corresponding entry is deleted from the server I/O configuration information table **113**.

The I/O switch assignment controlling unit **127** notices the processing result to the I/O switch assigning unit **108**.

FIG. **19** is a flowchart for explaining details of processes executed by the cross bus switch controlling unit **405** included by the I/O switch **120** according to an embodiment of the present invention.

The cross bus switch controlling unit **405** is called from the I/O switch assignment controlling unit **127** of SVP **119** (step **1271**). The cross bus switch controlling unit **405** changes the logical port establishing a correspondence between the physical ports of the I/O device **117** and the server **115** which are connected to the I/O switch **120**.

The cross bus switch controlling unit **405** determines which of an assign-add instruction or an unassignment instruction is the assignment change instruction issued from the I/O switch assignment controlling unit **127** (step **4051**).

In a case where the assignment change instruction is the unassignment instruction, the cross bus switch controlling unit **405** makes the cross bus switch **404** execute a processing of unassigning the correspondence between the physical port and the logical port (step **4053**), and proceeds to step **4054**.

Specifically, there are deleted pieces of information stored to the assignment group **4062** of entry in correspondence with the port number **1132** and the logical port number **4063** included in the unassignment instruction.

In a case where it is determined that the assignment change instruction is the assign-add instruction, the cross bus switch controlling unit **405** makes the cross bus switch **404** execute a processing of corresponding the physical port and the logical port (step **4052**), and proceeds to step **4054**.

Specifically, the cross bus switch controlling unit **405** adds the identifier of the assigned group to be pertained to the assigned group **4062**. The cross bus switch controlling unit **405** adds the logical port number **4063** to the assigned group. The logical port number **4063** stores a number which is different from the logical port number **4063** which has already been set to the assigned group.

The cross bus switch controlling unit **405** updates the port management table **406** (step **4054**), and finishes the processes (step **4055**).

That is, a piece of information is added to corresponding entry, or a piece of information of entry is deleted.

FIG. **20** is a flowchart for explaining details of a processing executed by the I/O device management unit **105** included in the management server **101** according to an embodiment of the present invention.

The I/O device management unit **105** manages flow amount information of the I/O device **117** assigned to the object server **115**. The I/O device management unit **105** determines the I/O device **117** equivalent to the I/O device **117** assigned to the object server **115**.

The I/O device management unit **105** acquires the I/O definition **1124** of the object server **115** from the server management table **112** (step **1051**).

The I/O device management unit **105** specifies the I/O device **117** assigned to the object server **115** (step **1052**).

Specifically, the I/O device management unit **105** specifies the I/O device assigned to the object server **115** in reference to the server I/O configuration information table **113** based on the I/O definition **1124** acquired at step **1051**. At this occasion, there are acquired the I/O switch identifier **1131**, the port number **1132**, the connection device **1133**, the communication destination **1134**, and the importance degree **1135**.

The I/O device management unit **105** acquires a flow amount of the specified I/O device **117** (step **1053**).

Specifically, the I/O device management unit **105** acquires the consumed band rate **1116** of the specified I/O device **117** in reference to the I/O switch management table **111** based on the I/O switch identifier **1131** and the port number **1132** which are acquired at step **1052**.

The I/O device management unit **105** calls the I/O device flow amount determining unit **107** (step **1054**).

A description will be given later of details of processes executed by the I/O device flow amount determining unit **107** in reference to FIG. **21**.

The I/O device management unit **105** continues waiting until a processing result of the I/O device flow amount determining unit **107** is noticed.

The I/O device management unit **105** to which the processing result is noticed from the I/O device flow amount determining unit **107** determines whether there is a difference in the I/O switch management table **111** based on the processing result noticed from the I/O device flow amount determining unit **107** (step **1055**).

Specifically, the I/O device management unit **105** determines whether a difference is brought about in a piece of information of the I/O switch management table **111** acquired at step **1053** based on the processing result noticed from the I/O device flow amount determining unit **107**.

In a case where it is determined that the difference is not present at the I/O switch management table **111**, the I/O device management unit **105** proceeds to step **1057**.

In a case where it is determined that the difference is present in the I/O switch management table **111**, the I/O device management unit **105** updates the I/O switch management table **111** for reflecting the difference (step **1056**).

The I/O device management unit **105** calls the I/O device flow amount controlling unit **109** (step **1057**), and finishes the processes (step **1058**). The I/O device management unit **105** combines pieces of information acquired at step **1051** through step **1053** to notice to the I/O device flow amount controlling unit **109**.

A description will be given later of details of a processing executed by the I/O device flow amount controlling unit **109** in reference to FIG. **22**.

FIG. **21** is a flowchart for explaining processes executed by the I/O device flow amount determining unit **107** included by the management server **101** according to an embodiment of the present invention.

The I/O device flow amount determining unit **107** is called from the I/O device management unit **105** (step **1057**). The I/O device flow amount determining unit **107** executes a determining processing with regard to a flow amount of the I/O device **117** assigned to the object server **115**.

Specifically, the I/O device flow amount determining unit **107** calculates the used band rate **1116** for each I/O type (LAN/SAN), and changes the service type **1125** to a switch in a case where the band restriction range **1117** is exceeded.

The I/O device flow amount determining unit **107** specifies the I/O device **117** assigned to the object server in reference to the server management table **112** and the server I/O configuration information table **113** (step **1071**).

At step **1071**, a method the same as that at step **1041** is used.

At step **1071**, there are acquired the I/O switch identifier **1131**, the port number **1132**, the connection device **1133**, the communication destination **1134**, and the importance degree **1135** as pieces of information of the specified I/O device **117**.

The I/O device flow amount determining unit **107** acquires a piece of information with regard to the specified I/O device **117** in reference to the I/O switch management table **111** based on the pieces of information acquired at step **1071** (step **1072**).

Specifically, the I/O device flow amount determining unit **107** acquires the consumed band rate **1116** and the band restriction range **1117** of the specified I/O device **117** in reference to the I/O switch management table **111** based on the I/O identifier **1131** and the port number **1132** which are acquired at step **1071**.

At this occasion, in a case where the specified I/O device **117** includes CNA as an adapter, the consumed band rate **1116** is acquired for each I/O type (LAN/SAN).

The I/O device flow amount determining unit **107** executes a processing described above with regard to all the specified I/O devices **117** (step **1072**).

The I/O device flow amount determining unit **107** determines whether the consumed band rate **1116** is within the band restriction range **1117** for each I/O type (step **1073**). This is because in the I/O device **117** including CNA as an adapter, there is a case where a band which can be used by SAN is not sufficient since the consumed band rate **1116** in LAN is high even when the consumed band rate **1116** of a total of the I/O device **117** is within the range of the band restriction range **1117**.

In a case where the specified I/O device **117** includes CNA as an adapter, different determinations are executed with regard to the consumed band rate **1116** for LAN and the consumed band rate **1116** for SAN.

The I/O device flow amount determining unit **107** determines whether the consumed band rate **1116** of the I/O device **117** is larger the upper limit value of the band restriction range **1117** based on a result of the determining processing at step **1073** (step **1074**).

In a case where it is determined that the consumed band rate **1116** of the I/O device **117** is equal to or less than the upper limit value of the band restriction range **1117**, the I/O device flow amount determining unit **107** finishes the processes (step **1076**).

In a case where the I/O device **117** includes CNA as an adapter, processes are executed respectively for the consumed band rate **1116** of LAN and the consumed band rate **1116** of SAN.

In a case where there are the plural specified I/O devices **117**, the processing described above is executed for all of the I/O devices **117**.

In a case where it is determined that the consumed band rate **1116** of the I/O device **117** is larger than the upper limit value of the band restriction range **1117**, the I/O device flow amount determining unit **107** updates the I/O switch management table **111** (step **1075**).

Specifically, the consumed band rate **1116** is updated such that all the consumed bands of the I/O devices **1117** are larger than the upper limit value of the band restriction range **1117**.

The I/O device flow amount determining unit **107** changes the service type **1125** of the server management table **112** (step **1075**), and finishes the processes (step **1076**). Specifically, the service type **1125** is changed from "0" to "1".

An assign-add processing of the I/O device **117** is executed in a processing at step **1046** by processes at step **1075** and step **1076**.

FIG. **22** is a flowchart for explaining processes executed by the I/O device flow amount controlling unit **109** included by the management server **101** according to an embodiment of the present invention.

The I/O device flow amount controlling unit **109** is called from the I/O device management unit **105** (step **1057**). The I/O device flow amount controlling unit **109** selects the equivalent I/O device **117** from the I/O device **117** assigned to the object server **115** in order to change the assigned I/O device **117**.

Here, the equivalent I/O device **117** indicates the I/O device **117** in which the connection device **1133** and the communication destination **1134** stay the same.

The I/O device flow amount controlling unit **109** retrieves the equivalent I/O device **117** from the I/O device **117** connected to the object server **115** (step **1091**).

Specifically, first, the I/O device flow amount controlling unit **109** specifies the I/O device **117** connected to the object server **115**. Next, the I/O device flow amount controlling unit

109 retrieves the I/O device 117 in which the connection device 1133 and the communication destination 1134 of the specified I/O device 117 stay the same.

The I/O device flow amount controlling unit 109 determines the assigned I/O device 117 for each I/O type from the retrieved I/O device 117, notices the determined I/O device 117 to the I/O controlling unit 126 (step 1092), and finishes the processes (step 1093).

Specifically, the I/O device flow amount controlling unit 109 determines the I/O device 117 having the least used band, that is, the least consumed band rate 1116 for each I/O type based on the consumed band rate 1116 of the retrieved I/O device 117.

The I/O device flow amount controlling unit 109 acquires a piece of information with regard to the determined I/O device 117. Specifically, there are acquired the identifier (I/O switch identifier 1131) of the I/O switch 120 connecting the determined I/O device 117, and the identifier (port number 1132) of the port to which the I/O device 117 is connected.

A method of determining the assigned I/O device 117 is not limited to the method described above. For example, there is conceivable a method of utilizing the band information of the network of the communication destination of the I/O device 117, the access destination of each I/O type, or the importance degree 1135 of the server I/O configuration information table 113 of the I/O device 117. For example, the method may be a method of determining to assign the fixed I/O device 117 in the specific I/O type.

The I/O device flow amount controlling unit 109 issues the assignment change instruction including the I/O switch identifier 1131 and the port umber 1132 to the I/O switch assignment controlling unit 127.

The I/O switch assignment controlling unit 127 executes the processes shown in FIG. 18. The cross bus switch controlling unit 405 executes processes shown in FIG. 19. Contents of the processes executed stay the same, and therefore, an explanation thereof will be omitted. The cross bus switch controlling unit 405 executes a processing of changing the correspondence between the physical port 407 and the logical port.

FIG. 23 is a flowchart for explaining processes executed by the I/O analyzing unit 125 included by the server 115 according to an embodiment of the present invention.

The I/O analyzing unit 125 analyzes the I/O frame, and determines the communication destination to which the I/O device 117 is connected for each I/O request.

The I/O analyzing unit 125 determines the I/O type of the I/O request by receiving the I/O request from the server 115 and analyzing the I/O frame (step 1251).

The I/O analyzing unit 125 acquires a target and a piece of device information of the access destination from the received I/O request (step 1252).

According thereto, there is conceivable a method of acquiring the target and the piece of device information by analyzing an IP address stored to an IP header, and an MAC address of Ether frame in a case where the I/O frame is LAN.

When the I/O type is HBA, there is conceivable a method of identifying a piece of network information to which the target pertains based on the communication destination 1134 of the server I/O configuration information table 113 by analyzing SCSI ID information of SCSI protocol.

The I/O type unit 125 determines the used I/O device 117 from the I/O device 117 which is determined by the I/O device flow amount controlling unit 109 for each I/O type (step 1253).

Specifically, the used I/O device 117 is determined based on the I/O type, the target of the access destination, and the piece of device information.

In a case where there are plural I/O devices 117 assigned to the server 115, the I/O analyzing unit 125 determines the I/O device 117 using the I/O device 117 having the least band consumed band rate 1116.

The I/O analyzing unit 125 acquires a piece of information of the determined I/O device 117 from the I/O switch management table 111. Specifically, the I/O analyzing unit 125 acquires the I/O switch identifier 1111, the port number 1112, the consumed band rate 1116, and the band restriction range 1117.

Thereafter, the I/O analyzing unit 125 calls the I/O controlling unit 126 (step 1254), and finishes the processes (step 1255).

A description will be given later of details of processes executed by the I/O controlling unit 126 in reference to FIG. 24.

At this occasion, the I/O analyzing unit 125 also notices the I/O switch identifier 1111, the port number 1112, the consumed band rate 1116, and the band restriction range 1117.

FIG. 24 is a flowchart for explaining processes executed by the I/O controlling unit 126 included by the server 115 according to an embodiment of the present invention.

The I/O controlling unit 126 is called from the I/O analyzing unit 125 (step 1254). The I/O controlling unit 126 transmits the I/O request received the I/O device 117 determined by the I/O analyzing unit 125.

The I/O controlling unit 126 acquires a piece of information of the I/O device 117 determined by the I/O analyzing unit 125 (step 1261).

Specifically, there are acquired the I/O switch identifier 1111, the port number 1112, the consumed band rate 1116, and the band restriction range 1117.

The I/O controlling unit 126 transmits the I/O request received by the I/O analyzing unit 125 to the determined I/O device 117 based on a piece of information acquired at step 1261 (step 1262), and finishes the processes (step 1263).

The I/O device 117 used at step 1262 is determined based on a piece of information of the consumed band rate 116 and the band restriction range 1117. Thereby, the consumed band rate of the I/O device 117 can be dispersed or biased.

FIG. 25 is a flowchart for explaining processes executed by the I/O device performance acquiring unit 110 included by the management server 101 according to an embodiment of the present invention.

The I/O device performance acquiring unit 110 periodically executes processes explained below.

The I/O device performance acquiring unit 110 acquires a flow amount of the I/O device 117 connected to the I/O switch 120. The I/O device performance acquiring unit 110 updates the I/O switch management table 111 based on the acquired flow amount of the I/O device 117.

The I/O performance acquiring unit 110 specifies the I/O device 117 assigned to the server 115 in reference to the server management table 112 (step 1101).

A processing at step 1101 is the same as the processing at step 1041. Therefore, at step 1101, there are acquired the I/O switch identifier 1131, the port number 1132, the connection device 1133, the communication destination 1134, and the importance degree 1135.

The I/O device performance acquiring unit 110 acquires a piece of information of the specified I/O device in reference to the I/O switch management table 111 (step 1102).

In the processing at step 1102, the consumed band rate 1116 and the band restriction range 1117 are acquired. As a method of acquiring the consumed band rate **1116** and the band restriction range **1117**, there is conceivable a method of acquiring the consumed band rate **1116** and the band restriction range **1117** from the I/O device **117** or the I/O switch **120**.

The I/O device performance acquiring unit **110** determines whether a difference is present in the I/O management table **111** (step **1103**). That is, it is determined whether respective values of the I/O switch management table **111** are changed.

In a case where it is determined that the difference is not present in the I/O switch management table **111**, the I/O device performance acquiring unit **110** finishes the processing (step **1105**).

In a case where it is determined that the difference is present in the I/O switch management table **111**, the I/O device performance acquiring unit **110** updates the I/O switch management table **111** (step **1104**).

The I/O device performance acquiring unit **110** determines whether the consumed band rate **1116** is within the band restriction range **1117** for all of the I/O devices **117** by using the consumed band rate **1116** and the band restriction range **1117** (step **1105**).

At step **1105**, at least either one of step **1044** or step **1045** is executed.

In a case where it is determined that the consumed band rate **1116** is not within the band restriction range **1117**, the I/O device performance acquiring unit **110** calls the I/O service controlling unit **103** (step **1106**), and finishes the processes (step **1107**).

In a case where it is determined that the consumed band rate **1116** is within the band restriction range **1117**, the I/O device performance acquiring unit **110** finishes the processes (step **1107**).

According to the embodiment of the present invention, in a case of changing the assignment of the I/O device **117** to the server **115**, the I/O device **117** in consideration of the I/O type and the network topology information can be selected, and therefore, the assignment can be changed to the pertinent I/O device **117**. Therefore, the flow amount of the I/O device **117** can be controlled.

Thereby, the load applied on the specific I/O device **117** can pertinently be dispersed. The I/O transfer efficiency of the I/O device **117** can be increased.

Although the explanation has been given of the embodiments of the present invention as described above, the embodiments are exemplifications for explaining the present invention and are not limited only to modes exemplifying the adaptive range of the present invention. Any combinations of the embodiments described above can be embodiments of the present invention.

What is claimed is:

1. An I/O device management method in a computer system which includes a computer, a plurality of I/O devices connected to a plurality of networks having different network configurations, an I/O switch assigning a first I/O device of the I/O devices to the computer so as to be able to communicate with a first one of the networks connected to the first I/O device, and a management computer managing the first I/O device assigned to the computer,

the management computer having a first processor, a first memory connected to the first processor, and a first network interface connected to the first processor, and

the computer having a second processor, a second memory connected to the second processor, and a second network interface connected to the second processor,

the I/O device management method comprising:

a first step of acquiring, by the management computer, a piece of I/O device configuration information of the first I/O device assigned to the computer, and a piece of network configuration information of the first one of the networks connected with the first I/O device assigned to the computer;

a second step of acquiring, by the management computer, a flow amount indicating an amount of data transmitted and received via the first I/O device assigned to the computer for each of a plurality of I/O types of the data transmitted and received via the first I/O device;

a third step of determining, by the management computer, whether to change the first I/O device assigned to the computer to another one of the I/O devices based on the flow amount acquired for each of the plurality of I/O types, the piece of the acquired I/O device configuration information, and the piece of the acquired network configuration information; and

a fourth step of issuing, by the management computer, an assignment change instruction to the I/O switch to change the first I/O device assigned to the computer to the other one of the I/O devices.

2. The I/O device management method according to claim **1**,

wherein the second step includes:

acquiring a consumed band amount at the first I/O device, and a usable band amount indicating a band usable at the first I/O device,

wherein the third step includes:

determining whether the flow amount of the first I/O device assigned to the computer is deficient based on the acquired consumed band amount and the acquired usable band amount; and

determining the other one of the I/O devices to be newly assigned to the computer when the flow amount of the first I/O device assigned to the computer is deficient.

3. The I/O device management method according to claim **1**,

wherein the second step includes:

acquiring a consumed band amount at the first I/O device, and a usable band amount indicating a usable band at the first I/O device,

wherein the third step includes:

determining whether there is an excess band amount at the first I/O device assigned to the computer based on the acquired consumed band amount and the acquired usable band amount; and

determining whether the first I/O device assigned to the computer can be unassigned when the excess band amount is present at the first I/O device assigned to the computer, and

wherein the fourth step includes:

issuing an unassignment instruction for unassigning the first I/O device to the computer when the assignment of the first I/O device having the excess band amount can be unassigned.

4. The I/O device management method according to claim **1**,

wherein the second step includes:

acquiring consumed band amounts for each of the plurality of I/O types consumed at the first I/O device, and usable band amounts at the first I/O device, and

wherein the third step includes:

determining whether the first I/O device is deficient in the consumed band amount of at least one of a plurality of I/O types in the first I/O device assigned to the computer based on the acquired consumed band amounts, and the acquired usable band amounts for each of the plurality of I/O types consumed at the first I/O device;

retrieving the other one of the I/O devices capable of transmitting and receiving data to and from the first one of the networks connected to the first I/O device when the first I/O device is deficient.

5. The I/O device management method according to claim **4**, wherein the other one of I/O devices can transmit and receive the data having the same plurality of I/O types as the first I/O device, and the network configuration of the first one of the networks connected to the first I/O device stays the same.

6. The I/O device management method according to claim **1**, wherein the first I/O device and at least one other of the I/O devices are assigned to the computer, and

further comprising:

acquiring data transmitted from the computer by the I/O switch;

extracting the plurality of I/O types and transmission destinations of the acquired data from the acquired data by the I/O switch;

determining which of the I/O devices are transmitting the acquired data from the I/O devices assigned to the computer based on the plurality of I/O types of the acquired data and the transmission destinations of the acquired data by the I/O switch; and

transmitting the acquired data from the determined I/O devices by the I/O switch.

7. A computer system comprising:

a computer;

a plurality of I/O devices connected to a plurality of networks having different network configurations;

an I/O switch assigning a first I/O device of the I/O devices to the computer so as to be able to communicate with a first one of the networks connected to the first I/O device; and

a management computer managing the first I/O device, where the management computer includes a first processor, a first memory connected to the first processor, and a first network interface connected to the first processor,

wherein the computer includes a second processor, a second memory connected to the second processor, and a second network interface connected to the second processor, and

wherein the second memory of the management computer stores instructions, that when executed by the second processor, cause the second processor to:

acquire a piece of I/O device configuration information of the first I/O device assigned to the computer, and a piece of network configuration information of the first one of the networks connected with the first I/O device assigned to the computer;

acquire a flow amount indicating an amount of data transmitted and received via the first I/O device assigned to the computer for each of a plurality of I/O types of the data transmitted and received via the first I/O device;

determine whether to change the first I/O device assigned to the computer to another one of the I/O devices based on the flow amount acquired for each of the plurality of I/O types, the piece of the acquired I/O device configuration information and the piece of the acquired network information, and

issue an assignment change instruction to the I/O switch to change the first I/O device assigned to the computer to the other one of the I/O devices.

8. The computer system according to claim **7**, wherein the flow amount acquired for each of the plurality of I/O types includes a consumed band amount at the first I/O device, and a usable band amount at the first I/O device,

wherein the second memory of the management computer stores instructions, that when executed by the second processor, cause the second processor to:

determine whether the flow amount of the first I/O device assigned to the computer is deficient based on the acquired consumed band amount and the acquired usable band amount when determining to change the change the first I/O device;

determine the other one of the I/O devices to be newly assigned to the computer when the flow amount of the first I/O device assigned to the computer is deficient.

9. The computer system according to claim **7**, wherein the flow amount acquired for each of the plurality of I/O types includes a consumed band amount in the first I/O device, and a usable band amount usable in the first I/O device,

wherein the second memory of the management computer stores instructions, that when executed by the second processor, cause the second processor to:

determine whether an excess band is present in the first I/O device assigned to the computer based on the acquired consumed band amount and the acquired usable band amount when changing the assignment of the first I/O device to the computer is determined;

determine whether the assignment of the first I/O device having the excess band can be unassigned when the excess band is present in the first I/O device assigned to the computer; and

issue an unassignment instruction for unassigning the first I/O device to the computer when the assignment of the first I/O device having the excess band can be unassigned as the assignment change instruction.

10. The computer system according to claim **7**, wherein the flow amount acquired for each of the plurality of I/O types includes a consumed band amount of each of the plurality of I/O types consumed at the first I/O device, and a usable band amount in the first I/O device,

wherein the second memory of the management computer stores instructions, that when executed by the second processor, cause the second processor to:

determine whether the first I/O device is deficient in the consumed band amount of at least one of the plurality of I/O types in the first I/O device assigned to the computer based on the acquired consumed band amounts, and the acquired usable band amounts in each of the plurality of I/O types consumed at the first I/O device;

retrieve the other one of the I/O devices capable of transmitting and receiving data to and from the first one of the networks connected to the first I/O device when the first I/O device is deficient.

11. The computer system according to claim **10**, wherein the other one of the I/O devices can transmit and receive the data having the same plurality of I/O types as the first I/O device, and the piece of network configuration of the first one of the networks connected with the first I/O device stays the same.

12. The computer system according to claim **7**, wherein the first I/O device and at least one other of the I/O devices are assigned to the computer, and

wherein the I/O switch:

acquires data transmitted from the computer;

extracts the plurality of I/O types of the data and transmission destinations of the acquired data;

determines which of the I/O devices are transmitting the acquired data from the I/O devices assigned to the computer based on the plurality of I/O types of the acquired data and the transmission destinations of the acquired data; and transmits the acquired data from the determined I/O devices.

13. A non-transitory, computer readable medium storing an I/O device management program causing a management computer to execute a process for managing a computer, a plurality of I/O devices connected to a plurality of networks having different network configurations, an I/O switch assigning a first I/O device of the I/O devices to the computer so as to be able to communicate with a first one of the networks connected to the first I/O device, and the first I/O device assigned to the computer, the management computer comprising a first processor, a first memory connected to the first processor, and a first network interface connected to the first processor,

the process comprising:

a first procedure of acquiring a piece of I/O device configuration information of the first I/O device assigned to the computer, and a piece of network configuration information of the first one of the networks connected with the first I/O device assigned to the computer;

a second procedure of acquiring a flow amount indicating an amount of a data transmitted and received via the first I/O device assigned to the computer for each of a plurality of I/O types of the data transmitted and received via the first I/O device;

a third procedure of determining whether to change the first I/O device assigned to the computer to another one of the I/O devices based on the flow amount acquired for each of the plurality of I/O types, the piece of acquired I/O device configuration information and the piece of acquired network configuration information; and

a fourth procedure of issuing an assignment change instruction to the I/O switch to change the first I/O device assigned to the computer to the other one of the I/O devices.

14. The computer readable medium storing the I/O management program according to claim **13**,

wherein the second procedure further includes acquiring a consumed band amount in the first I/O device, and a usable band amount in the first I/O device,

wherein the third procedure further includes:

determining whether the flow amount of the first I/O device assigned to the computer is deficient based on the acquired consumed band amount and the acquired band amount; and

determining the other one of the I/O devices to be newly assigned to the computer when the flow amount of the first I/O device assigned to the computer is deficient.

15. The computer readable medium storing the I/O management program according to claim **13**,

wherein the second procedure further includes:

acquiring a consumed band amount in the first I/O device, and a usable band amount in the first I/O device,

wherein the third procedure further includes:

determining whether an excess band amount is present in the first I/O device assigned to the computer based on the acquired consumed band amount and the acquired usable band amount; and

determining whether the assignment of the first I/O device having the excess band amount can be unassigned when the excess band amount is present in the first I/O device assigned to the computer, and

wherein the fourth procedure further includes:

issuing an unassignment instruction for unassigning the first I/O device to the computer when the assignment of the first I/O device having the excess band amount can be unassigned.

16. The computer readable medium storing the I/O management program according to claim **13**,

wherein the second procedure further includes:

acquiring a consumed band amount for each of the plurality of I/O types consumed in the first I/O device, and a usable band amount in the first I/O device, and

wherein the third procedure further includes:

determining whether the first I/O device is deficient in the consumed band amount of at least one of the plurality of I/O types in the first I/O device assigned to the computer based on the acquired consumed band amounts for each of the I/O types, and the acquired usable band amount;

retrieving the other one of I/O devices capable of transmitting and receiving data to and from the first one of the networks connected to the first I/O device when the object first I/O device is deficient.

17. The computer readable medium storing the I/O management program according to claim **16**,

wherein the other one of the I/O devices can transmit and receive the data having the same plurality of I/O types as the first I/O device, and the network configuration of the first one of the networks connected to the first I/O device stays the same.

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